Sri Serfoji Rajah
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THE ANATOMY OF THE HUMAN BODY.

VOL. III.

CONTAINING THE

NERVOUS SYSTEM,

WITH PLATES.

PART I.
THE ANATOMY OF THE BRAIN, AND DESCRIPTION OF THE COURSE OF THE NERVES.

PART II.
THE ANATOMY OF THE EYE AND EAR.

By CHARLES BELL,
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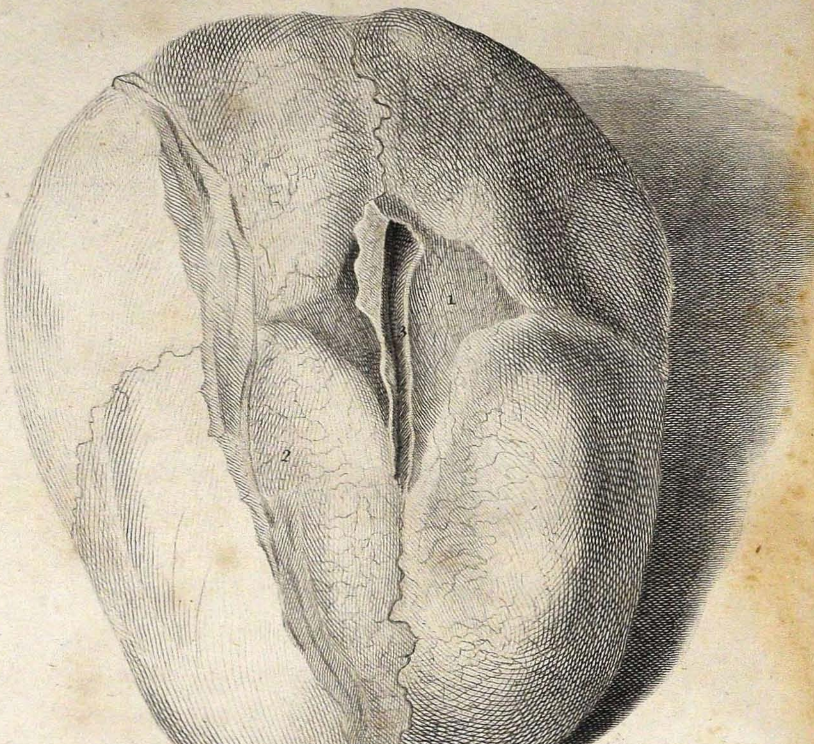
ERRATUM.

P. 288. l. 14. for "outer surface," read "inner surface."



the Scull:cap of a Child before it be fully Ossified ..1 the Fontanelle . 2 the Perecranium extremely: Vascular..3 the Longitudinal Sinus opened by cutting up the membrane in the direction of the Sagittal Suture

INTRODUCTORY VIEW

OF THE

NERVOUS SYSTEM.

There can be no natural divifion of the nervous fyftem, for it is a whole fo connected in function, that no one part is capable of receiving or imparting any fenfation, or of performing the operation of the intellect.

The fyftem has, notwithftanding, been arbitrarily divided into the brain and nerves; the brain being fubdivided into the cerebrum, cerebellum, and medulla oblongata; while the nerves are fubdivided into the nerves of the fenfes, the vital and involuntary nerves, the nerves of voluntary motion.

The BRAIN is defined to be that foft mafs contained within the cranium, from which the nerves are propagated to the organs of the fenfes and over the body, beftowing fenfation, and acting as the agents of the will. It is believed to be the receptacle of fenfation and the inftrument of thought; but our ideas of its functions are vague and imperfect.

The ſubſtance of the brain is delicate and ſoft, and poſſeſſes a degree of elaſtic reſiſtance; but the nerves are firm, hard, and devoid of elaſticity; becauſe, though their peculiar ſubſtance has equal delicacy with the brain, their membranes give them firmneſs and ſtrength to enable them to paſs through the moving parts of the body without being bruiſed, or having their function affected. The ſubſtance of the brain is protected and ſupported by the ſcull and dura mater: its peculiar matter is ſupported and nouriſhed by the pia mater. The nerves contain the ſame matter with the brain; but in their courſe through the body this matter is diſguiſed by the peculiar ſtructure of their membranes, which, while they ſupport their ſubſtance, nouriſh them alſo, as the membranes do the brain. But the extremities of the nerves are again reduced to the ſame delicate texture with the brain.

In the ſtructure of the brain and nerves there is an analogy with the other parts of the body. In a bone or a muſcle there is the ſame intexture of membranes ſupporting the peculiar ſubſtance which is the characteriſtic of the part, and conveying blood veſſels for its nouriſhment. The muſcular fibres, or the earth of bone, are, in the midſt of this inveſting membrane, peculiar parts diſtinct in their properties, as the medullary ſubſtance of the nerves is amidſt the cellular membrane, which divides them into faſciculi, and gives them their fibrous appearance.

When it is ſaid that the nerves are productions of the brain, we are not to underſtand that they are propagated from it to the diſtant parts of the body, as if drawn out from it like a thread from the wool. In the embryo

embryo the nerves are laid in their ſheaths, extending to the remoteſt parts of the body. They are connected with the brain, and in this ſenſe they may be conſidered as elongations of it, the perfect function of both depending upon their union. But they have powers independently of the brain; and often an animal is produced having no brain; and yet, in ſuch embryo, the animal functions are ſufficiently perfect.

In the ſame manner, when the trunk of the nerve of a limb is cut, it is only deprived of its connection with the brain, the centre of the nervous ſyſtem; and little further effect is produced than the deſtruction of the powers of the will over the limb; the nutrition and growth of the part continue, and the action of thoſe parts, which are independent of the will, as the muſcular power of the veſſels of the limb, remains entire.

The nerves of animals are in proportion to the ſize of their bodies; but in many of the great tribes of animals the brain bears no ſuch proportion. The nerves of the organs alſo bear a relation to the neceſſities of the animal, not to the ſize of the brain. If the procuring of ſuſtenance depend upon the power of the organ of ſmelling, or upon the ear, or the eye, or even the bill, an additional ſupply of nerves is provided, or a peculiar apparatus of nerves ſuiting to the exigency. This alſo ſhews a property in the nerves independent of the brain.

We come to this concluſion, that the nerves are analogous to the brain, (being indeed a matter ſimilar in ſtructure and function to it,) diffuſed over the body, and included like it in the pia mater, or in a ſimilar delicate and vaſcular membrane, and that their proper

ſubſtance, conſiſting like the brain of a cineritious and medullary matter, is nouriſhed by theſe membranes. We muſt conclude alſo, that they are more independent of the brain than the brain is of them; for the nerves are capable of continuing the operations of the animal body independently of the brain; but without the communication of ſenſation through the nerves to the brain, its function muſt be unexerciſed.

The nerves, in their courſe through the body, form ganglions, plexus, and networks. By theſe a more univerſal connection of the ſeveral branches of the ſyſtem is maintained, ſo that few if any nerves can be traced to one point or origin. When the nerves form ganglions, (which are like knots or ſwellings upon them,) their fibres are ſplit and irregularly diſperſed, while there intervenes a peculiar ſubſtance reſembling the ſtriæ of the cineritious ſubſtance in the brain. From every analogy we muſt ſuppoſe, that thoſe ganglions anſwer in a leſs degree the purpoſe of that more univerſal connection which the nerves have with the brain.

In their extremities again the nerves are peculiarly organized: a nerve, in its courſe, is incapable of receiving any diſtinct ſenſation; when injured, it conveys to us the undefinable ſenſation of pain; and from the connection with the muſcles, and with the whole ſyſtem, it ſhakes the limb with involuntary tremors, or ſudden ſpaſms. The ſuſceptibility of thoſe peculiar impreſſions which the organs of the ſenſes convey, depends upon a ſtructure diſtinct from that of the brain, and diſtinct alſo from that of the nervous cords; and this organization is ſo peculiar, that the nerves of one ſenſe are quite incapable

pable of receiving the impreffions which thofe of another are fitted to convey, though apparently to our reafoning thofe impreffions appear to be capable of producing a ftronger effect upon the nerves.

As the vital organs muft be in perpetual action to fupport life, nature has guarded thofe functions by making them independent of the will, and lefs immediately dependent on the function of the brain. This is a provifion which allows the exhaufted mental and bodily functions to be recruited by fleep, while the operations of the animal body neceffary to life go on uninterrupted.

It is an additional reafon for believing the ufe which we have affigned to the plexus and ganglions to be the true one, that thofe nerves which fupply the vital organs arife by fmall twigs from the brain, take a long courfe through the body, and neither fwell out into large nerves, nor are finally diftributed until they have received many additions, and formed feveral remarkable plexus and ganglions.

As in fleep the vital functions continue uninterrupted, fo the difeafes of the brain, which refemble fleep, fuddenly deprive the body of all voluntary exertion, while the vital motion remains for a time unimpaired, and finks gradually, for no part of the body is altogether independent of the healthy function of the brain.

It is neceffary alfo that we fhould recollect the connection of the higher attributes of a living being with the animal economy.

The brain, the nerves, and the nervous expanfions in the organs of the fenfes, are dependent for the perpetual renewal and fupport of their function upon the circula-

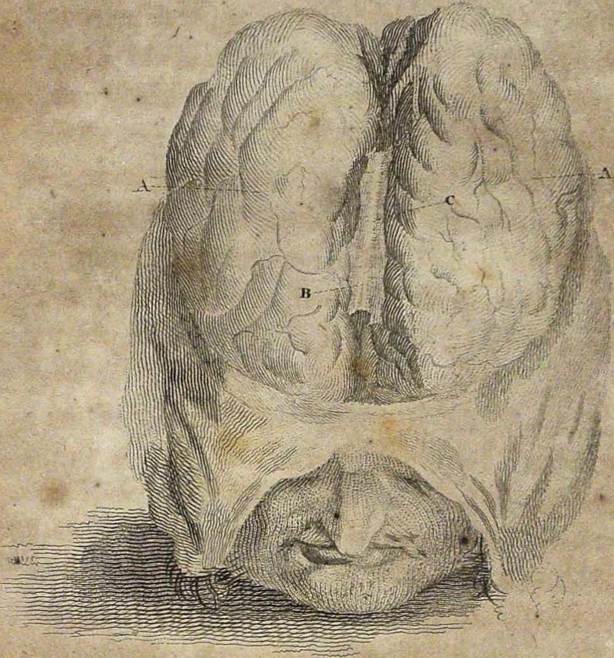
 tion

tion of the blood. We ſhould be tempted to imagine, that the nervous ſyſtem were a nobler part of the economy, did we not frequently ſee the powers of the mind as well as the functions of the nerves diſturbed, or altogether overthrown by the irregularities of the bodily ſyſtem; were we not thus reminded of that circle of connections and mutual dependences which ſupport the whole. If the tide of blood flow too rapidly upon the brain, the intellect is diſordered, the ideas come in rapid and irregular ſucceſſion. If the exit of the blood from the head be obſtructed, there is an obſtruction to the circulation of the blood in the extremities of the veſſels of the brain; the function of the brain is ſuddenly ſuppreſſed, becauſe, though its attributes ſeem ſo peculiar, it requires the perpetual circulation of the blood through it to renovate its powers.

The effect of the circulation of the blood through the nerves of the limb is not leſs remarkable. If the nerve of a limb be cut or tied, the animal can no longer move the limb, having loſt the power of the will over it. But if the great artery of a limb be tied, the function of the nerve is, in a ſhort time, equally deſtroyed, becauſe the circulation of the blood through the nerve being obſtructed, it loſes its powers, and is no longer a living part.

Thus, whilſt the moving powers of the circulation of the blood are dependent on the ſtate of the nervous ſyſtem, the nervous ſyſtem is as immediately dependent on the healthy ſtate of the blood, and the velocity of the circulation.

With this general view of our ſubject, we proceed to inveſtigate the anatomy of the brain as a diſtinct part, without forgetting the unity of the ſyſtem.



A.A. *Hemispheres of the Cerebrum*
B. *Corpus Callosum* C. *Rapha*

CHAP. I.

OF THE MEMBRANES OF THE BRAIN, AND OF THE SUBSTANCE AND TEXTURE OF THE BRAIN ITSELF.

OF THE DURA MATER.

MANY Authors, while they deſcribe the cranium as containing the brain, conceive that it alſo gives it ſhape. But the brain is formed before the bones which inveſt it. The firſt thing that we obſerve in the embryo is

the diſproportionate ſize of the brain to the diminutive body. The oſſification of the bones of the ſcull is a gradual proceſs. The brain, already formed, is inveſted with the ſtrong membranes; and betwixt the laminæ of the outer membrane the points of oſſification commence, and are not completed until the ninth year. The bony matter, which is depoſited betwixt the layers of this membrane, retains a firm connection and interchange of veſſels with the now apparently diſtinct membranes on its inner and outer ſurfaces. The outer layer, which is ſo ſtrong in children newly born, becomes the delicate pericranium, whilſt the inner layer is the dura mater. Thus we find that the bones of the head are moulded to the brain, and the peculiar ſhapes of the bones of the head are determined by the original peculiarity in the ſhape of the brain.

This view corrects an error into which many have fallen, that the dura mater and the veſſels ramifying upon it impreſs their form upon the ſolid bones, and wear channels upon their ſurface by their inceſſant pulſation. The membranes and veſſels precede the formation of the bone, and the oſſeous matter is depoſited ſo as to be moulded round the veſſels *.

Thus the dura mater may be conſidered as the internal pericranium †.

* Albini Acad. Anat. "Quomodo cranium creſcendo accomodat ſe eis quæ continet."

Fiſcher, Diſſertatio de modo, quo, oſſa ſe vicinis accomodant partibus.

† Some regard only its external lamina as the internal pericranium. Fallopius firſt viewed the dura mater in this light, and he is followed by the beſt anatomiſts.

The

The dura mater * is a firm and ſomewhat opaque membrane.—When the ſcull-cap is torn off, and it is cleaned from the blood which eſcapes from the ruptured veſſels, it is ſeen marbled with azure and roſy colours. It partakes more of the former in youth than in thoſe advanced in years, or in the robuſt and ſanguineous †. Its outer ſurface is rough, from the adheſions to the bone being torn up; but on the ſurface lying in contact with the brain, it is ſmooth, ſhining, and of a pearl colour.

Although the dura mater is really the ſtrongeſt membrane of the body, it is yet diviſible into laminæ; theſe are ſtrengthened and firmly connected by the intertexture of ſtrong fibres. Moſt anatomiſts deſcribe it as compoſed of two laminæ. Some however deſcribe three laminæ—the outer lamina, or ſquamoſa; the middle, or filamentoſa; and the internal (being ſmooth and uniform), the lamina membranoſa ‡.—But to ſeparate the dura mater into ſuch laminæ, it will, I believe, be neceſſary to dry it and tear it into ſhreds. No doubt it may be poſſible thus to tear it, as ſome have done, into four, ſix, ſeven, or even eight laminæ or

* The membranes of the brain have the name of *mater*, becauſe they defend the brain and protect its tender ſubſtance, or, according to ſome anatomiſts of the Arabian ſchool, becauſe the other membranes of the body are produced from them. Before Galen, the term Meninx was common to all the membranes of the body, afterwards it was appropriated to thoſe of the brain.

† Malacarne Encefalotomia Nuova, p. 19.

‡ Malacarne, p. 22. It is deſcribed as partly tendinous, partly ligamentous: that is to ſay, of a nature reſembling theſe, yet not altogether the ſame. Vicq. d'Azyr found it ſeparated by purulent matter into two laminæ, the fibres of which had a different direction. Acad. de Sciences, An 1781. p. 497.—Bartholin Sp. Hiſtor. Anatomiæ.

ſquamæ.

ſquamæ. It is to be regretted that anatomiſts ſhould have been proud of ſuch diſſections, or that any ſuch deſcriptions ſhould be thought creditable to their authors, or diſcoverers as they are called.

The dura mater is inſenſible; it has, in the way of experiment, been pricked and injured by every poſſible contrivance, by mechanical and by chemical ſtimulants; yet the animals, the ſubjects of ſuch cruel experiments, have given no ſign of pain*. Before this fact of the inſenſibility of the dura mater was thus eſtabliſhed, phyſicians regarded this membrane as the ſeat and origin of many diſeaſes †.

Formerly the natural connection of the ſcull and dura mater was ſo reſolutely denied—ſo hotly conteſted among the various parties in anatomy and ſurgery, that we might, by reading their diſputes, almoſt doubt one of the plaineſt and moſt obvious facts, were not the cloſeneſs of this connection ſufficiently proved by the manner of the original formation of the cranium, by the reſiſtance to the tearing up of the cranium, and by the bleeding ſurface of the dura mater; or, if further proof be required, we may macerate theſe bones and their membranes in acids, when the laminæ of the dura mater will be ſeen intimately connected with the bone, while the pericranium and outer laminæ of the dura mater are ſeen to be continued into each other ‡, by

* Zinn. Exper. circa corpus calloſum, cerebellum, duram meningem.—Mem. par Haller ſur les parties ſenſibles et irritables.—Blegny Journal de Med. An 1. p. 16.

† See Hoffman. Med. Ration: part 2. ſec: ii. c. 1. § 2. and Boneti Sepulch. Anat. lib. i. ſec. 1.

‡ Vicq d'Azyr Memoir. de l'Acad. Roy. 1781, p. 497, and Malacarne (Aderenze della D. M. alle pareti interne del cranio), p. 24,

the intermediate cellular texture in which the earth of the bones is depofited *.

The dura mater adheres more firmly to the bone in young fubjects, becaufe the bone is yet imperfect, and its furface fpongy and rough; and, for the fame reafon, it is more firmly attached to the fcull in the chronic hydrocephalus, becaufe the offification is imperfect.

It frequently adheres fo firmly to the fcull cap, as to leave its outer lamina adhering to the fcull when it is raifed. It adheres more firmly along the futures, and from this caufe, when the fcull is injured, and matter is formed under it, the dura mater will be feparated on each fide of the future, and ftill retain its adhefion to the future, fo as to divide the matter, and, confequently, prevent the full evacuation of the matter when the trepan has been applied on one fide of the future. The dura mater adheres alfo with peculiar firmnefs to the bafe of the fcull, becaufe of the numerous chinks and foramina.

GLANDS OF THE DURA MATER.

UPON the external furface of the dura mater there are little holes, from which emerge flefhy-coloured papillæ, and which, upon examining the fcull cap, will be found to have correfponding foveæ. Thefe are the glandulæ Pacchioni †. They are in number from

* Taking a portion of the dura mater betwixt the finger and thumb, we can feel the two lamina moving upon each other, from a flight degree of laxity in the connecting cellular fubftance. This cellular texture is demonftrated by Malacarne, by forcibly injecting quick-filver betwixt the layers of the membrane.

† See M. Littre Acad. Roy. des Sciences 1704, Hift. p. 32. art. 19.

ten

ten to fifteen * on each ſide, and are ſeen chiefly lateral to the courſe of the longitudinal ſinus. Theſe bodies were ſuppoſed by Pacchioni to be glands. When preſſed they give out a fluid; but in this they do not differ from the looſe common cellular membrane. As they are chiefly ſeen along the line of the great ſinus, and are not ſcattered over the whole dura mater, their ſuppoſed uſe of moiſtening the ſurface of the membrane † is quite improbable; and, indeed, this is a part of that unfounded hypotheſis which ſuppoſed an interſtice betwixt the dura mater and ſcull, and aſcribed motion to this membrane. The ſurfaces of the dura and pia mater, where they are in contact, being of the nature of the ſecreting ſurfaces of the inveſting membranes of the other viſcera, require no ſuch further aid in moiſtening them, or preventing their adheſion. Many glands are deſcribed by authors in the ſubſtance, and upon both ſurfaces of the membrane ‡. Of the bodies which adhere to the ſurface of the pia mater, and of thoſe alſo which are to be ſeen in the ſinuſes, we ſhall ſpeak afterwards, when conſidering the veins which enter the longitudinal ſinus.

ARTERIES OF THE DURA MATER.

THIS membrane muſt neceſſarily be ſupplied with veſſels for its own nouriſhment, for that of the contiguous bone, and for the perpetual exudation of the fluid, or halitus rather, which moiſtens or bedews its internal ſurface. We may divide the arteries of the

* Haller, El. Phyſ. p. 106, Mem. par M. Vicq d'Azyr Mem. de l'Acad. Roy. 1781, p. 497.

† Viz. the opinion of Fantonius.

‡ Malacarne, ſec. 94.

dura mater into anterior, middle, and poſterior. The firſt proceeding from the opthalmic and ethmoidal branches; the ſecond from the internal maxillary and ſuperior pharyngeal; the poſterior from the occipital and vertebral arteries.

The principal artery of the dura mater, named, by way of diſtinction, the great artery of the dura mater, is derived from the internal maxillary artery, a branch of the external carotid. It is called the ſpinalis, or ſpheno-ſpinalis, from its paſſing into the head through the ſpinous hole of the ſphenoid bone, or meningea media, from its relative ſituation, as it riſes in the great middle foſſa of the ſcull *. This artery, though it ſometimes enters the ſcull in two branches †, uſually enters in one conſiderable branch, and divides ſoon after it reaches the dura mater into three or four branches, of which the anterior is the largeſt; and theſe ſpread their ramifications beautifully upon the dura mater, over all that part which is oppoſite to the anterior, middle, and poſterior lobes of the brain. Its larger trunks run upon the internal ſurface of the parietal bone, and are ſometimes for a conſiderable ſpace buried in its ſubſtance. The extreme branches of this artery extend ſo as to inoſculate with the anterior and poſterior arteries of the

* Malacarne, parte i. ſec. 100.

† Soemmerring de Corp. Hum. fab. tom. v. p. 142. This is not the ſole artery ſent to the dura mater from the internal maxillary, a twig alſo riſes from that branch which goes to the pteregoid muſcles and parts about the Euſtachian tube—it enters the ſcull, and is diſtributed to the 5th pair of nerves, and to the dura mater and cavernous ſinus. Another enters with the inferior maxillary nerve by the foramen ovale, and riſes upon the dura mater.

dura

dura mater, and through the bones (chiefly the parietal and temporal bones) they inoſculate with the temporal and occipital arteries *.

The meningeal artery has been known to become aneuriſmal and diſtended at intervals, it has formed an aneuriſm, deſtroying the bones, and cauſing epilepſy †.

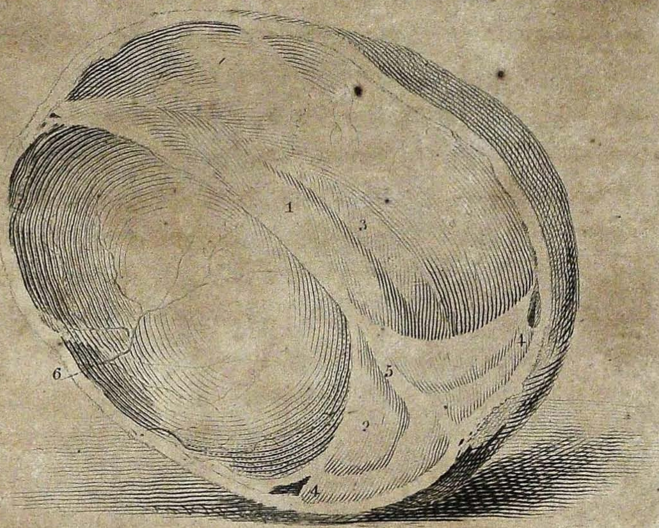
OF

* Malacarne.—" Antrorſum ramis arteriæ opthalmicæ, retrorſum " ramis arteriarum vertebralium, ſecuti etiam crebro ſibi ipſi, nec non " epicranii ramis, *e.g.* ex arteria occipitali ortis etc. in embryonibus " potiſſimum conſpicuis inoſculatur." Soemmerring, tom. v. p. 142.

† Malacarne, p. 1. ſec. 105. " Poſſono le arterie, della D. M. " devenire aneuriſmatiche, il che ho veduto in due cranii, in uno dei " quali l'arteria ſpinoſa era tutta gozzi tanto a deſtra quanto a ſiniſtra, " i maggiori dei quali (ed erano cinque dal primo, e nove dall' altero " lato) poco ſuperàvano la groſſezza dei piſelli: nell' altero ancor giove- " nile ſi vedevano due ſoli gozzi uguali in diametro al mignolo ſul " tronco mezzano dell' arteria ſpinoſa rempetto alla metà del parietale " ſiniſtro, diſtanti nove linee circa l'inferior anteriore dall' altro." Part i. § 105. We have alſo the following caſe from Malacarne. " Juvenis ætatis 22 annorum, ſanguinei temperamenti, poſt vehe- " mentiſſimos, et frequentes epilepſiæ motus in noſocomio D. Joan- " nis, tumente in ſumma bregmatis oſſium parte capitis cute, ſub " meis oculis moriebatur. D. Caccia in hac noſtra univerſitate tunc " Botanices profeſſor, quem mihi patronum a morte peremtum adhuc " defleo, ut cadaver aperiretur juſſerat, atque in ejuſdem capite ex ea " parte, qua tenuiſſima devenerant oſſa, ob arteriarum ſubrepentium " inter duræ matris laminas aneuriſmata, os quoque omnino deficiens " reperiebatur, ſub capitis integumentis aneuriſmata magnitudinis " ovi columbini, exiguo, perruptoque foramine aperto, ut ſanguis ſub " integumentis concreviſcet; atque tunc novimus ad ea aneuriſ- " matum loca, quæ quidem utrinque erant, in vehementia morbi " ægrum pugnos infligere conſueviſſe."—A curious caſe occurred lately to a friend of mine: A boy was wounded with an arrow in his head; it ſtuck in the parietal bone; upon withdrawing it, there was a profuſe hæmorhagy, for its point had ſtruck the artery of the dura mater. The ſurgeon was cautious of applying preſſure, leſt the

blood

The Scull Cap with the D.ª M.ᵉ adhering.



1. *Falx*. 2. *Tentorium*, 3. *Longitudinal Sinus*
4. 4. *great Lateral Sinuses*. 5 *Fourth Sinus*
6. *Artery of the D.M.*

D. Lizars Sculp.

OF THE SEPTA WHICH INTERSECT THE BRAIN.

Thoſe ſepta, or, as they are called, proceſſes of the dura mater, being extended acroſs from the internal ſurface of the cranium, ſupport the brain in the ſudden motions of the body, and prevent the mutual gravitation

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blood ſhould force its way betwixt the dura mater and bone, or diffuſe itſelf upon the ſurface of the brain; he bled the boy largely in the arm, but it had no effect upon the hæmorhagy; and fearing to bring on a greater degree of inflammation by applying the trepan, he made a ſlight compreſſion, and in the now languid ſtate of the circulation, the bleeding was ſuppreſſed.

of

of its parts. Theſe partitions are formed by the internal lamina of the dura mater, which is reflected as the peritoneum is to form the meſentery, or the pleura to form the mediaſtinum.

The falx is the largeſt of the partitions; it is attached to the cranium in the line of the ſagittal ſuture, and reaching from the criſta galli of the ethmoid bone to the middle of the tentorium, or to the crucial ridge of the occipital bone, it paſſes deep into the middle of the brain, and divides it into its two hemiſpheres. It is in ſhape like a ſcythe, for anteriorly it does not paſs ſo deep into the ſubſtance of the brain; but it gradually becomes broader, or deſcends deeper betwixt the hemiſpheres, as we follow it backwards, which, with the curve, it neceſſarily takes from the ſhape of the cranium, has obtained it the name of falx: it is alſo called ſeptum ſagittale, verticale, or mediaſtinum cerebri.

The TENTORIUM ſeparates the cerebrum and cerebellum. It ſtretches horizontally over the cerebellum, and ſuſtains the poſterior lobes of the cerebrum. It is formed by the inner lamina of the dura mater, reflected off from the os occipitis alongſt the whole length of the grooves of the lateral ſinuſes, and the edge or angle of the temporal bones. This ſeptum, thus running round the cavity of the cranium, divides it into two departments; the upper one for the lodgment of the cerebrum, and the lower for the cerebellum. But to allow the union of theſe two great diviſions of the encephalon, a circular opening is left upon the anterior part of the tentorium, which is called the notch of the tentorium.

There is a little proceſs of the dura mater which may be called the FALX of the CEREBELLUM. It runs down

down upon the internal ſpine of the occipital bone from the tentorium, gradually contracting until it terminates on the margin of the great occipital foramen. It ſerves as a kind of ligament ſtrengthening the tentorium, while it divides the cerebellum. It enters, however, but a little way betwixt the lobes.

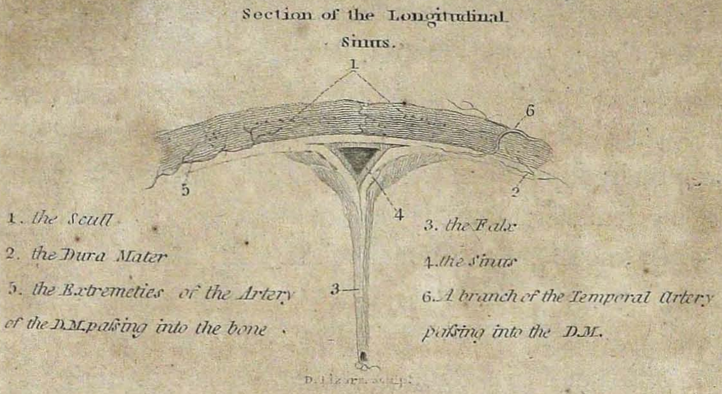
The falx and tentorium being connected and continued into each other at their broadeſt part, they mutually ſupport each other, and are extremely tenſe. This tenſeneſs depends on their mutual ſupport, for when one of them is cut the other falls looſe.

OF THE SPHENOIDAL FOLDS.

The lateral extremities of the tentorium are continued forward into acute lines, formed by the duplicature of the dura mater coming off from the edges of the pars petroſa of the temporal bones, and take firm hold on the poſterior clynoid proceſſes. From theſe two points a fold of the membrane ſtretches forward on each ſide to the anterior clynoid proceſs, forming thus a hollow or cell for the lodgment of the pituitary gland. Another fold or duplicature of the dura mater runs onwards a little way from the edge of the little wing of Ingratius. Theſe are the ſphenoidal folds.

Where the internal lamina of the dura mater forſakes the external to form the falx and tentorium, it leaves a channel or triangular canal; the baſis of which triangle is the lamina of the membrane inveſting the cranium, while the tenſion of the partitions carries the apex out into an acute point. This forms a channel for receiving all the blood of the veins, and this tenſion and triangular ſhape gives a degree of incompreſſibility

to the canals. Theſe are the ſinuſes which receive the veins of the encephalon, and guard them from compreſſion :—



Upon the ſurfaces of the dura mater there are many lacerti, or ſlips of fibres, which are intricately interwoven with the main body of the membrane, and ſtrengthen it. Theſe fibres are peculiarly ſtrong in the angles, where the duplicatures paſs inwards, giving firmneſs to the ſinuſes, and allowing the veins to inſinuate their trunks betwixt them; theſe faſciculi, or ſlips of fibres, and the ſides of the ſinuſes, are the cordæ Williſianæ. They were conſidered by Baglevi and Pacchioni * as the tendons of the muſcles of the dura mater. Pacchioni conceived that this membrane was muſcular. Vicq d'Azyr obſerves, that in inflammation of the dura mater he has ſeen it red, and of a fleſhy appearance; and that ſuch a circumſtance might

* Theſe were Italian anatomiſts. Pacchioni was phyſician to Clement the XI.

have

have deceived Pacchioni, and made him believe that there were mufcular bellies *.

Thefe phyficians conceived that the contraction of the falx and dura mater raifed the tentorium; they even conceived that the action of the heart depended upon this motion of the dura mater †. They were deceived by the pulfation in the arteries of the brain, communicated to the dura mater, after the operation of trepan, or in their experiments on living animals ‡.

The motion communicated to the dura mater thofe Italian anatomifts conceived to depend on the rifing of the tentorium. This motion, which is occafioned by the beating of the arteries of the brain, had been long before obferved §: fome conceived it to be a motion in the brain itfelf, others believed it to depend on the finufes ‖.

* Mem. de l'Acad. Roy. 1781.

† Duverney.

‡ There is a diftinction in the movement of the dura mater to be obferved upon opening the fcull; one depending upon the pulfation of the arteries of the brain; the other caufed by an obftruction to the exit of blood from the cranium, depending upon the lungs. "On voyoit bien la pulfation des arteres du cerveau, qui communi-"quoient quelque mouvement à la dure mere, mais ce mouvement "n'avoit aucune fymmetrie avec celui de la refpiration. Fatigué de "ne rien voir après avoir fi bien vû je comprimai la poitrine de l'ani-"mal: auffitot le cerveau fi gonfla, evidemment par le reflux du fang "de la poitrine qui rempliffoit la jugulaire.—Je lachai la poitrine, et "le cerveau redefcendit."—Exper. 78. Mem. ii. par Haller fur le Mouv. du cerv.—"Il arrivoit pourtant de tems en tems et fans que "cela continuat que le cerveau fe foulevoit dans l'expiration, et fe "laiffoit repomper dans l'infpiration." Exper. 79. f. chat

§ By Coiterus, Riolanus, Bartholin.

‖ Diemerbroeck.

The motion caused by respiration was likewise observed *. M. de Lamure's conclusion was, that the motion of the brain was caused by the reflux of the blood towards it from the vena cava in expiration †. He undertook to demonstrate this; and he conceived his proof to be good, when, by pressing the ribs of a subject, he saw the refluent blood swelling the jugular and abdominal cava. Haller observed the jugular veins swell, and become turgid, during expiration; and he concluded, that the motion of the brain was occasioned by the refluent blood distending the sinuses of the brain. But he did not believe, as Lamure did, that this motion took place before the opening of the cranium, as well as after it.

When the scull is opened by a wound, the dura mater still protects the brain, resisting inflammation, and giving the necessary and uniform support to the more delicate substance and vascular membrane of the brain; but when the dura mater is lacerated by the trepan, or punctured, or worn by the pulsation against the edge of the bone, there may be sudden hærnia of part of the brain from coughing, or a rapid and diseased growth from the pia mater forming a fungus. Such fungus is, in some degree peculiar to children, and is occasioned, I conceive, by the taking away of that due compression which the resistance of the dura mater ought to give.

* M. Schlichting Mem. des savans Etrangers, 1744. Lorry, Mem. present. a l'Acad. des Scien. par divers savants Etrangers.

† M. de Lamure; vide l'Acad. de Sciences, 1744.

OF

OF THE PIA MATER.

WHILE the dura mater is closely connected with the cranium, and in contact with the surface of the brain, but still unconnected with it, except by means of veins entering the sinuses (and that only in the course of the sinuses); the pia mater is closely attached to the brain, and passes into its inmost recesses. While the dura mater is firm and opaque, and not prone to inflammation, the pia mater is delicate, transparent, and extremely vascular. Like the dura mater, it is not endowed with sensibility*; it is of great strength, considering its apparent delicacy†.

The pia mater, which was formerly considered as a simple membrane, consists, in reality, of two membranes, the tunica arachnoides, and the proper pia mater, or tunica vasculosa ‡.

The TUNICA ARACHNOIDES was discovered and commented upon by a society formed by Blasius Sladus Quina and Swamerdam §. They called it Arachnoides, because of its extreme tenuity. It was called also Membrana Cellulosa, from the appearance it took when they insinuated a blow-pipe and blew it up, separating it from the pia mater.

This membrane is without the pia mater; and while the pia mater sinks down into the sulci of the brain,

* Haller, Oper. Minor. de Part. Corpor. humani sent. & irrit.

† Sir C. Wintringham Exper. Essays. Taken comparatively, it is stronger than the aorta.

‡ There are many, however, who with Lieutaud consider the arachnoid coat as the external lamella of the pia mater.

§ This was in 1665. I am, perhaps, not correct in saying they discovered it; for Varolius describes it plainly, covering the medulla oblongata.

this covers the ſurface uniformly, without paſſing into the interſtices of the convolutions, or into the ventricles *.

This membrane is ſo extremely thin, that it cannot by diſſection be ſeparated for any conſiderable ſpace from the pia mater, and leaſt of all, over the middle hemiſpheres of the brain. By the blow-pipe, indeed, we may raiſe it into cells, but it immediately ſubſides again; on the poſterior part of the cerebellum, on the ſpinal marrow and baſe of the brain, it is more eaſily raiſed and demonſtrated †. It does not paſs deep into the ſulci of the brain, but unites them by an extremely delicate cellular texture.

The view which would incline me to conſider the tunica arachnoides merely as a layer of the pia mater is this: when the vaſcular pia mater deſcends into the ſulci, the tunica arachnoides does not follow it, but keeps to the uniform ſurface of the brain; but when this vaſcular membrane is about to enter into ſome of the leſſer ſulci which are within the larger, it again parts with another lamella, while its more vaſcular part deſcends ſtill deeper into the brain.

OF THE PROPER PIA MATER, OR TUNICA VASCULOSA.

The pia mater is a ſimple membrane, without either tendinous aponeurotic or muſcular fibres. It is extremely vaſcular, but it is tranſparent in the interſtices of its veſſels: it is the membrane which immediately inveſts

* Haller Elemen. Phyſ. tom. iv. ſec. viii. p. 7.

† F. Ruyſchii Reſponſio ad A. os Goelecke Epiſtol ix. See Bidloo, table 10; but the membrane is ſo delicate (nulla detur in corpore ſubtilior, Ruyſch) that it can be but very imperfectly repreſented by engraving.

 and

and connects itself with the substance of the brain; and although delicate, it forms the support and strength of its ceneritious and medullary substance. All vessels distributed in the body, however minute, are always conveyed in membranes; the pia mater then follows, or rather conveys the vessels not only into the cavities of the brain, but to every part of its substance, it being intimately blended with it *. We see it more distinctly descending in strong plicæ into the interstices of the convolutions; nor is it into them only that it enters, but into every pore which conveys a vessel †. The pia mater as it passes into the substance of the brain, divides and subdivides into partitions and cells, and every capillary vessel, and every molicule of the substance of the brain is invested and supported by its subdivisions. The pia mater is to the brain what the cellular membrane is to the other viscera and parts of the body; for it is the peculiar matter lying in the interstitious cellular membrane (as in muscles, bones, &c.) that gives the peculiarity of character to the parts ‡; the

* Columbus, the assistant of Vessalius, and afterwards Professor in Rome, explained this intimate intertexture of the pia mater with the proper substance of the brain, so far back as 1559.

† When we tear off the pia mater from the brain (for it cannot be called dissection), it does not adhere merely at the sulci, but to the whole surface of the convolutions; and every where small vessels enter, and with these vessels descends also the lamina of the pia mater.

‡ "Sed cum continuo triduo in inquisitione facienda perseverassem; tandem deprehendi cerebri fibrillas eadem ratione, continuataque serie, sibi invicem annexas esse; quemadmodum fibrillas carneas tendinibus adhærere demonstravi; cum igitur illam cerebri cum vasis sanguineis connexionem deprehendissem; et eam, quam ante dixi, variorum fructuum compagem attenderem; iterum con-

the cellular membrane itſelf is nearly alike in all; therefore, in my judgment, the pia mater is rightly conſidered by ſome anatomiſts as a cellular ſubſtance *.

Malacarne ſays, I am much inclined to conſider it with the illuſt. Haller as being compoſed of lamina, like common adipoſe membrane, and that the extreme arteries ramify through its cells, for, with a blow-pipe, we can raiſe it into cells like the common membrane; and if this be carefully done, the air may be made to paſs from cell to cell, following the arteries in their courſe betwixt the lobuli, and in the ſubſtance of the brain †. We can follow the pia mater into the ventricles, by tracing it betwixt the poſterior lobe of the cerebrum and the cerebellum, where it forms the velum interpoſitum of Haller, and paſſes under the fornix. We can follow it alſo into the poſterior horn of the lateral ventricles from the baſe of the brain, where the branches of the middle artery of the cerebrum paſs into the lower part of the choroid plexus; we trace it alſo into the bottom of the fourth ventricle. The pia mater lining the ventricles is more delicate, and leſs

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"cluſi dominum, univerſi conditorem, in rerum creatarum fabrica "eaſdem vel conſimiles fere leges tenuiſſe."—"Igitur adverti fibrillas "certo loco ſibi conjunctas, mox alio loco ab invicem divertere, paulo "poſt iterum coëuntes. Et, ſi recte memini, conſimiles conjunctiones obſervavi in muſculis cordis," &c. Leeuwenhoek Epiſt. Phyſ. xxxiv.

* Bergen. Program de pia matre. See Haller Anat.

† Such is the profuſion of veſſels diſtributed to inconceivable minuteneſs, that it has been conſidered as entirely compoſed of veſſels, and received the name of chorion, from the membrane of the ſecundines. Galen de uſu part. l. viii. cap. 8. Malacarne, part 1, ſec. 243.

vaſcular

vafcular than that feen upon the furface, and betwixt the convolutions of the brain.

It has been faid that the ventricles of the encephalon ferved to increafe the furface of the pia mater, and that whatever purpofes are ferved by that membrane and its veffels on the furface of the brain, we muft fuppofe the fame performed by it within the ventricles *. This feems more like a weighty conclufion than it really is. We have feen how minutely diftributed the pia mater is through the fubftance of the brain, independently of the ventricles; and we fhall find that the ventricles have important ufes, without the neceffity of fuppofing them fo fubfervient to the diftribution of the pia mater.

As the tunica arachnoides is of a peculiar nature, and has few if any veffels, and as it covers the external furface of the brain only, it feems to me probable that this membrane is the caufe why effufions in the ventricles are fo common, and why fluids are fo feldom found betwixt the furface of the brain and the dura mater. When by the difeafed action of the veffels of the pia mater on the furface of the brain an effufion is thrown out, it very feldom lies upon the furface unconfined; but frequently fluids are contained in facs of the arachnoid coat, betwixt the convolutions of the brain, or raife it into pellucid veficles upon the furface. The want of a tunica arachnoides upon the pia mater of the ventricles, may be a caufe of the fluids being fo much more readily fecreted into them.

The raifing of the pia mater into veffìcles by the action of the veffels of the pia mater, is rather an ar-

* Dr. Monro's Nervous Syftem, chap. vi.

gument for the diſtinct nature of theſe membranes. The tunica arachnoides is raiſed by the action of the veſſels of the pia mater, as the cuticle is raiſed into bliſters by the inflammatory action of the veſſels of the cutis, while no other membranes of the body take ſuch an appearance in their diſeaſe. They inflame, indeed; they thicken; their lamina become more diſtinct, or their cellular ſubſtance fills with water, or hydatids are formed in them; but this appearance of water ſecreted under the tunica arachnoides is quite peculiar.

OF

Section of the right Hemisphere

1 *Central Medullary Matter* 2 *Ceneretious or Cortical Matter.*

OF THE SUBSTANCE OF THE BRAIN.

The cerebrum and cerebellum confift diftinctly of two very different fubftances; the cineritious and medullary matter. The cineritious, or afh-coloured matter, forms the fuperficial or outer part of the encephalon, and is therefore called alfo the cortical part. The cineritious matter varies much in colour; in the crura cerebri it is very dark; in the pons varolii it is reder; in the corpora olivaria* it is yellower. The confiftency

* Vicq d'Azyr.—" Exterior cerebri totius facies, donec in fpinalem medullam abeat, plerumque colore eft fubrubride cinereo, vel languide ruffeo. Fufciora funt cerebra fanguine ditia, *e. g.* hominum apoplexia enectorum, vel hominum craffioris fanguinis; pallidiffima vero funt cerebra hydropica vel hominum pituitoforum vel " hæmorrhagia,

ency of this matter alſo varies conſiderably in different parts; it is ſoft in the baſe of the brain, betwixt the optic nerves and anterior commiſſure, and in the third ventricle. The medullary matter is chiefly in the internal part of the brain, forming a kind of nucleus or white central part; but in many parts of the brain, there is a mixture of theſe which form ſtriæ *; and in ſome of the eminences, the internal part is cineritious, while the external part, or what we might here call the cortical part, is medullary †.

The cortical or cineritious ſubſtance does not blend gradually with the white medullary matter, but on the contrary, their line of diſtinction is abrupt: an intervening ſubſtance has been obſerved. In inflammation of the brain, particularly, it has been ſaid, that this third ſubſtance has been found. This may be merely the effect of light upon the union of the two ſubſtances. We, however, often obſerve an appearance of ſucceſſive coloured circles upon the edge of the medullary matter of the arbor vitæ, in the cerebellum.

" hæmorrhagia mortuorum. Dubio procul color cerebri ſanguinis " temperaturam ſequitur, et ideo pallidius eſt infantibus, quam adul- " tis." Sommerring hum. corp. fab. vol. iv. p. 41.

* Thus the cineritious ſubſtance is mixed with the medullary matter in the corpus calloſum, in the corpora ſtriata, the thalami nervorum opticorum, in the tubercula quadrigemina, the immenentia mamillaria; in the crura cerebri; in the pons varolii; in the corpora olivaria, and medulla ſpinalis.

† " E xerampelina ſulla ſuperficie del cervelletto, e dei corpi ſcanalati quando non evvi aqua nei ventricoli; foſca nei talami de' nervi ottici, e nelle gambe del cervello, dove quà e là ſuole avere del nericante giallognola zolferina, e talvolta granadiglia, nelle eminenze olivari." Malacarne, parte ii. ſec. 15.

It has been aſſerted by M. Ludwig *, that the maſſes and ſtriæ of the cineritious ſubſtance, diſperſed through the internal parts of the brain, have a communication with each other. This, however, is denied by Vicq d'Azyr †. He conceives, that the cineritious ſubſtances of the pons varolii, or of the corpora olivaria, have no communication with the cineritious ſubſtance in any other part of the brain; and that in ſeveral parts of the brain the cineritious ſubſtance is ſurrounded and iſolated by the medullary matter. Its great importance (which ſhould never have been doubted) has been deduced from its being ſo generally found towards the origin of the nerves ‡.

The cineritious ſubſtance ſeems to have a much greater quantity of blood circulating in it than the medullary ſubſtance. Its veſſels come by two diſtinct routs, partly from the extremities of thoſe arteries which appear in large branches upon the ſurface of the brain, and partly by veſſels which penetrate through the me-

* De cinerea cerebri ſubſtantia, Lepſiæ.

† Hiſt. de l'Acad. Roy. an 1781. p. 507.

‡ Il faut que les uſages de la ſubſtance griſe ſoient tres-importans; car independamment de la portion de cette ſubſtance que les circonvolutions contiennent, et qui ſemble appartenir à la maſſe blanche du cerveau, ou en obſerve des amas plus ou moins conſiderables pres des diverſes origines des nerfs: ainſi pres de la premiere et la deuxieme paire, ſont les corps ſtries et les couches optiques; la troiſieme paire eſt pres d'un eſpece noiratre que je decrirai ailleurs; la quatrieme paire fort au deſſous des tubercules quadrijumcanx, dont le noyau eſt compoſè de ſubſtance griſe, la cinquieme, la ſixieme, la ſeptieme, ſe trouvent aux environs de le portuberance annulaire, ou la ſubſtance griſe eſt mêlée avec la blanche; la huitieme et la neuvième ſont placées près de l'eminence olivarie, où j'ai obſerve un mélange particulier de ſubſtance griſe. Mem. de l'Acad. Scien. an 1781. p. 507.

dullary

dullary ſubſtance from the baſe of the brain. Ruyſch and Albinus have made the moſt minute injections of this part of the brain. The former conceived it to conſiſt entirely of veſſels; but Vicq. d'Azyr and Albinus found always, in their experiments, that a great proportion of it remained colourleſs after the moſt minute injection. It is, indeed, very improbable, that ſo ſoft a body ſhould be entirely compoſed of veſſels. How, for example, can we ſuppoſe the comiſſura mollis, or cineritious matter, on the ſides and bottom of the third ventricle, or the almoſt tranſparent lamina, which we find in ſome parts, to be compoſed of veſſels?

The white MEDULLARY SUBSTANCE appears to be a pulpy maſs. We obſerve no peculiarity of ſtructure in it towards the ſurface of the brain, where it is contiguous to the cortical matter; but towards the origin of the nerves it takes a more fibrous appearance. This appearance of fibres is not owing to any peculiarity in the medullary matter, but to the manner in which the pia mater involves it. The medullary matter, being chiefly internal, has every where through the brain a communication from the fore to the back part, from the upper part to the baſe; from the great central part it extends in form of ſtriæ, into the corpora ſtriata and thalami; it inveſts the eminences in the lateral ventricles; and thoſe upper parts have communication with the medullary ſubſtance of the baſe.

M. Meckel found, upon comparing the brains of an European and of a negro, that the medullary matter differed very much in colour. In the negro, inſtead of the whiteneſs of the European, the medullary matter was of a yellow colour, and nearly like the cineritious

matter:

matter: he obſerved alſo, that this very peculiar diſtinction of colour was only to be obſerved when the ſection was recently made, and that the darker colour of the medullary matter became fainter when expoſed to the air*.

OF THE OBSERVATIONS MADE UPON THE MINUTE STRUCTURE OF THE BRAIN.

THE opinions regarding the ſtructure of the brain have had a dependence on the general doctrines of the ſtructure of other ſecreting organs, and it is, of courſe, connected with the diſputations of Malpighi and Ruyſch, becauſe the doctrine of the glandular nature of the brain, and the belief of the nervous fluid, being a ſecretion, has, in all ages, formed the baſis of the moſt favourite theories †.

Malpighi found, on throwing in black and fluid injection, that there remained always particles colourleſs, and to which the injection did not penetrate. He conceived theſe to be glandular folicules, and that the cineritious ſubſtance of the brain conſiſted of this folicular

* "La moelle du negre etoit d'un jaune clair, tirant un peu ſur "le gris, tandis que celle de l'Europeen etoit d'une parfaite blan-"cheur." "Celui du negre etoit d'un jaune noiratre et celui de "l'Europeen d'une couleur blanche—Prolongeant enſuit la diſſec-"tion juſqu aux grands ventricules du cerveau j'ai coupé horizontale-"ment les corps ſtries et les couches des nerfs optiques. C'eſt la où la "difference a paru vraiment etonnante, le corps ſtrie dans le negre "etant preſque de la couleur brune d'une ecorce d'arbre, au lieu que "celui de l'Europeen etoit couleur de chair pale tirant au cendre," &c.

† Indeed this doctrine of the glandular nature of the brain has deſcended from Hippocrates—"Caput quoque ipſum glandulas "habet cerebrum enim eſt ut glandulæ album eſt et friabile," &c.

OF

or glandular ſtructure, while the medullary matter of the brain was merely the fibrillæ of the excretory duct. This opinion was founded on conjecture, with but a very poor ſhew of experiments, viz. by boiling the ſubſtance of the brain in oil, he found it take a granulated appearance, as if formed of ſmall grains, or little glands*.

Such was the received opinion until Ruyſch, with a deſpotical authority, ſwayed the opinions of phyſiologiſts: he alleged, in proof only his own experiments and preparations, in which other anatomiſts could not follow nor refute him, and therefore they acquieſced. His moſt unanſwerable and moſt inſulting argument was "veni et vide†."

According to Ruyſch, the cortical ſubſtance of the brain is entirely vaſcular, and has no appearance of a glandular or folicular ſtructure; nay, he conceived it to be entirely compoſed of arteries ‡. But as Malacarne obſerves, though we ſuppoſe the extremities of

* "Pedamentum, ſupra quod poſita eſt philia in qua conſervatur "portio cerebri in liquore, quam decoxi in oleo olivarum per horas, "ſicuti, facere aſſolet Dr. Vieuſſens. Ea autem plane *mutilis et per-* "*verſa eſt preparatis*, nam nihilum quidem vaſculoſi viſui occurrit "poſt decoctionem in dicto oleo, et quod unuſquiſque tentare poteſt "ita ut inventor neutiquam habendus ſit Dr. Vieuſſens Sc. quod "cerebri cortex nil ſit, niſi extremitates vaſorum ſanguineorum: in "ea autem nemo hactenus (quod ſciam) me imitari poterit aut anolo-"gum quid fecit." Ruyſch Theſ. An. x. No. xxxii.

† "Milites quando hoſtium adventum audiunt, clamant ad arma! ad "arma! ſic ego dico hic ad viſum! ad viſum!" Reſponſio ad J. Ch. Bohlium.

‡ Vieuſſens was latterly of the ſame opinion, and is accuſed of plagiariſm by Ruyſch. Accordingly, we find, that in ſome parts of his works he deſcribes the glands and ducts of Malpighi.

the

the arteries of the cineritious ſubſtance to be more minute than thoſe which are diſtributed to the microſcopical corpuſculi of the ſmalleſt viſible inſect, there muſt ſtill remain ſome part, which is not compoſed of veſſels; and in regard to the veins of the cineritious ſubſtance we may appeal to Albinus, who, from the ſubſtance of the brain, finds many veins connected with the arteries of the cineritious ſubſtance when he carefully lifts the pia mater. But there is this peculiarity in the diſtribution of the blood veſſels of the brain, that, though the cineritious ſubſtance be the moſt vaſcular, yet, in the medullary matter, we ſee the veſſels with large open mouths, and more diſtinct than in the cineritious ſubſtance. In following the blood veſſels from the baſe of the brain into the medullary ſubſtance, we ſee them diſtinct, and of conſiderable magnitude; but when they are about to enter the cineritious ſubſtance, they diſperſe into minute branches *. In the ſame manner thoſe arteries, which are carried into the ſulci of the ſurface by the pia mater, branch into extreme

* Leeuwenhoeck ſaw, in the ſubſtance of the brain, but eſpecially in the cortical ſubſtance, red blood veſſels, but ſo delicate, that he could not comprehend how the globules of the red blood could paſs along them; and what appeared more particular, they were of a deeper colour than the red particles themſelves; for, when ſeen ſingly, they appeared to have very little colour. This he explained by an experiment made upon a certain little animal. After it had ſucked blood very plentifully, he obſerved, that the blood was broken down by digeſtion, and conveyed through the limbs and horns of the creature, ſo as to make it univerſally red. So here he conceives that the globules of the blood may be broken down and altered in their ſhape to enter the minute veſſels of the brain.

minutenefs before they finally penetrate the cineritious fubftance *.

Leeuwenhoeck † obferved, in the cortical fubftance of the brain, a pellucid, chriftalline, and to appearance oily matter; he calls this, therefore, the fubftantia vitrea. When he had put a fmall portion of this under his glafs, he faw a fluid, which he at firft conceived might have efcaped from the globules that were neceffarily cut by the knife. This fluid alfo he found to confift of very minute globules, thirty-fix times lefs than thofe of the blood ‡. Thefe fmall globules he conceived to have probably conftituted a fluid, which, during the life of the animal, was moveable, and in veffels, though now in death congealed and fixed §. The colour of the cortical fubftance he found to depend upon the minute ramification of the veffels which were of a dark brown colour, while, in the medullary part, they were clearer and more tranfparent. Independently of this diftinction of veffels, he could obferve little difference in the medullary and cineritious fubftance; the refraction of the rays of light amongft the tranfparent globules being the caufe of the whitenefs of the former.

* Malacarne, Part II. fect. 18.

† He was born in Delft, in Holland, 1632, and died 1723. He is celebrated for his microfcopical difcoveries; his papers are chiefly in the Tranfactions of the Royal Society of London, about the year 1674.

‡ Anatomica Contemplatio, 30.

§ Among thofe globules, of which the brain is compofed, he faw alfo globules of the blood, which it was eafy to diftinguifh by their roundnefs. Thefe red globules, he fuppofes, had efcaped in confequence of the minute veffels having been cut by the knife.

 R. della

R. della Torre, in his microfcopical obfervations, defcribes globuli in the brain; he fays, that he faw them floating in a pellucid vifcous fluid. But Prochafka * thinks Della Torre muft be miftaken in this, for when he took a fmall portion of the brain, he faw it confifting of innumerable globules, which continued to adhere to each other, even after three months' maceration in water: and thence he concludes, that it could not be as R. della Torre conceived, that thefe fpherical bodies move from the brain on towards the extremities of the nerves; nor do thefe bodies lie imbeded in a glutinous fluid (he continues) but they are connected by the extremely minute and pellucid fepimentæ of the pia mater, and by the veffels which pervade both the cortical and medullary matter, and which nourifh as well as fupport and connect thefe corpufculi.

Prochafka cannot, from his own obfervations, determine whether thefe globular bodies be convoluted veffels, or what they are. R. della Torre had obferved, that they were largeft in the cortical part, lefs in the medullary fubftance, ftill diminifhing in the medulla oblongata, and leaft of all in the nerves; but fucceeding obfervation did not fupport this affertion †. Malacarne expreffes himfelf to be nearly of the fame opinion in regard to the veficular ftructure of the cortical fubftance of the brain. The minute proceffes of the pia mater, fays he, embrace and fupport the medullary fub-

* Tract. Anatom. de Struct. Nervorum.

† This was certainly a theoretical deception: it is like the accurate obfervation of Tracaffati, who could diftinguifh a difference of tafte in the medullary and cineritious fubftance of the brain.

 ftance,

ſtance, which is ſurrounded with a matter of a darker colour, and leſs diſtinctly fibrous, but not leſs eſſential, and which is compoſed of corpuſcules, that, in figure and arrangement, reſemble the veſicles of the pulp of a lemon *.

Many authors endeavour to ſupport their conjectures regarding this veſicular ſtructure of the brain by morbid diſſection †. We ſee the brain frequently degenerated into hydatids, or into little veſſels, or into knobular glandular-like ſchirroſities. I have ſeen this veſicular appearance in great portions of the pia mater. I have ſeen the pia mater with innumerable little bodies like milliary glands upon it; and alſo the whole upper and external part of the brain degenerated into one maſs of diſeaſe. It was hard, ſchirrous, tuberculated, and like a diſeaſed gland ‡. But I cannot conceive that any concluſion, in regard to the natural ſtructure of the brain, can be drawn from ſuch appearances. They are to be conſidered as the diſeaſes of the veſſels and membranes rather than of the peculiar matter of the brain.

When the brain is examined in the fœtus of the early months, although the ſubſtance of the brain is extremely ſoft, and even of a fluid conſiſtence, the membranes and veſſels are fully formed, exquiſitely minute, and perfect in all their proceſſes, ſo that they give form and firmneſs to the brain. We ſee, conſequently, that the due increaſe and complete organization of the brain is

* Malacarne, page 2. ſect. 4.

† Wepfer de cicuta aquatica. Mangetus.—Malacarne, &c.

‡ There has been obſerved a ſtructure like the bronchial gland. Huber, Obſervationes Anatom.—Acta Helvetica, 1758. Tom. iii.

a gra-

a gradual procefs, and like the growth of the other parts of the body.

OF THE SENSIBILITY OF THE SUBSTANCE OF THE BRAIN.

It cannot but appear ftrange, that the very fource or centre, to which every fenfation is referred, fhould itfelf be deftitute of fenfation; yet, we are affured, by the experiments of Haller and Zinn, that the cortical fubftance of the brain has been irritated, without the animal being convulfed, or giving figns of pain *; but when the medullary part of the brain is irritated, the effects are inftantaneous, and the animal is convulfed. It has been obferved, that as the injury of a nerve caufes convulfions, fo does that of the central parts of the brain, from which the nerves originate; but this fenfibility † diminifhes towards the furface of the brain ‡. We fee a diftinction betwixt the ftructure and function of the nerves and of the brain; or rather betwixt the cineritious fubftance of the brain and the nerves. For, although we muft neceffarily conclude, that the cineritious fubftance is an important and, perhaps, the moft effential part of the fyftem, ftill it does not evince, by

* But, like the infenfible membranes, it becomes irritable by difeafe; or by preffure, which affects the univerfal function of the brain. Vander Linden, in his Medicina Phyfiologica (1613), brings proof of the infenfibility of the brain. See the general enumeration of the effects of wounds in the brain. Haller Phyfiol. Tom. iv. &c. Obfervations par M. de la Peyronnie de decouvrir la partie de cerveau ou l'ame exerce les functions.—Acad. Roy. des Sciences.

† It is an effect different from pain or fenfation: it fhakes the body with violent convulfions.

‡ Sommering, tom. iv.

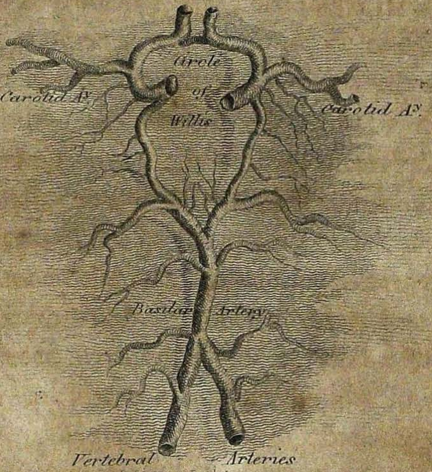
the immediate effect of injuries, that strict sympathy and universal connection which belong to the nerves.

The nearer to its source that a nerve is pricked, the greater is the effect of the injury. As it recedes from its origin towards the superficies of the brain, the effect is lessened, because the connections of the part are diminished in number, proportionally to their distance from the central parts of the brain; a puncture in the centre injures more filaments from their being concentrated to form nerves.

Several ounces of the brain have been lost in consequence of wounds, without death, or loss of memory, or intellect.

There is a very marked distinction betwixt puncturing, cutting, or even burning, the surface of the brain and pressing it. In the first there is little or no effect, or even pain. In the latter there is stupor, pain, or convulsions. The reason is, that in the first it is a local irritation in a place which has little, if any, feeling, while in the latter, the effect of the pressure spreads extensively.

No sensible man will expect, in the most minute and unwearied investigation of the structure of the brain, to find the explanation of its function. It is interesting to find effects so peculiarly connected with the operations of the mind, depending upon a structure of so gross and animal a nature as this of the brain, so far as we have seen; but still, all explanation of those operations must be visionary.



CHAP. II.

OF THE VEINS AND SINUSES OF THE BRAIN.

THE brain is very profusely supplied with blood, in so much, that the blood has been supposed to circulate in the brain in a proportion four times greater than in any other part of the body. This is the most moderate calculation, and it has been formed from a comparison of the quantity of blood circulating in the head, with that which circulates in the arm. Boerhaave and Kiel, comparing the area of the arteries of the cerebrum with that of the ascending aorta, made a most erroneous calculation of the proportion of blood circulating in the brain, compared with that of the rest of the body. Had they compared the quantity of blood within the head with that of the lungs, of the liver, of the spleen,

or of the kidney, the difference would have been lefs ftriking.

Wherever there is great arterial vafcularity, we are fure to find alfo peculiarities in the venous fyftem of the part; wherever we find an accumulation of tortuous arteries paffing to a gland, we fhall alfo find the veins tortuous and large; or wherever the arteries of a part take a difeafed action, the effect of this action will be found moft perceptible in the change which the veins undergo. In fhort, the effect of difeafe is much more furely to be difcovered in the venous than in the arterial fyftem; and no where is this better exemplified than in the brain.

The following appear on the firft view to be the moft ftriking peculiarities in the veins of the brain; their fize; the little connection they feem to have with the furrounding cellular membrane; and the inconfiderable fupport which they appear to receive from it; their having no valves; their being in their courfe diftinct from the arteries; and laftly, their not being gathered into great trunks, but emptying themfelves into the finufes of the dura mater.

It is not eafy to conceive how the veins of the brain fhould have been fo much overlooked by the older anatomifts; but from the diffections of Albinus, and the microfcopical obfervations of Leeuwenhoek, we have authority for what is, perhaps, in itfelf fufficiently evident, that the veins of the furface of the brain are derived from minute ramifications conveyed in the delicate pia mater; and that thefe, as in the other parts of the body, proceed from the extremities of the arteries, without any apparent peculiarity in the connection be-

twixt the extremities of the arteries and the veins of thebrain *.

The defcription of the veins of the brain, previous to their entering the finus, has been neglected. I divide them into the external and internal veins of the brain, or thofe which emerge from its fubftance, and are feen upon the furface; and thofe which, coming chiefly from the fides of the ventricles, are convoluted in the plexus choroides, and terminate in the fourth finus.

OF THE VEINS WHICH ARE SEEN UPON THE SURFACE OF THE BRAIN.

Vicq d'Azyr has been minute in his attention to the veins of the furface of the brain. He confirmed the obfervation, that almoft all the veins which pafs into the longitudinal finus, open in a direction contrary to the ftream of blood in the finus †. Thefe fuperficial

* The obfervation is trivial; but we muft recollect, that Vefalius contradicted Galen, and affirmed, that the finufes received alfo arteries which gave them their pulfation. This opinion was refuted by Fallopius, but adopted by Vieuffens, Wepfer, and others, upon the idea of the facility with which injection paffes from the arteries into the finufes; while, on the other hand, Ruyfch conceived that the cortical part of the brain confifted entirely of arteries.

† From Vicq d'Azyr's table we fhould be led to conclude, that the veins did not decidedly all open with their mouths oppofed to the ftream of blood. Ridley afferts, that one half open backwards. Santorini alfo obferves great variation in the direction of thefe veins. Lower, while he obferved this direction backwards, defcribes them, at the fame time, as paffing obliquely betwixt the coats, like the gall duct in the inteftine, or the ureters into the bladder.

ficial veins of the ſurface of the hemiſpheres, are in number generally from ten to fifteen on each ſide. They really do not ſeem to be worthy of the minute attention which Vicq d'Azyr has beſtowed upon them; he has moſt carefully deſcribed each individual branch, and that not in general terms, but firſt thoſe of the right, and then thoſe of the left ſide. Now, although theſe veins do not enter the ſinus oppoſed to each other, nor in pairs, ſtill the irregularity is trifling, and were it important, does not admit of deſcription. Thoſe veins do not lie in the ſulci of the brain, but paſs occaſionally along the interſtices, or over the convolutions of the brain; they take in general a courſe from before backwards, but previous to their entering the ſinus, are turned forwards. We have already obſerved, that the pia mater and dura mater have no connection, but at the place where thoſe veins enter the lamina of the dura mater; and here their connection is ſomewhat peculiar. It is not a ſimple adheſion of the pia mater and dura mater; but a white ſpongy ſubſtance ſeems to connect and ſtrengthen them, and, when torn aſunder, it leaves a ſoft fatty kind of roughneſs upon the pia mater. Theſe appear to me to be

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der. Sabbatier ſays decidedly, that they enter with their mouths oppoſed to the courſe of the blood in the ſinus. From Malacarne, we ſhould be led to conceive (what I believe to be the truth) that they open very irregularly. "Non tutte queſte vene ſboccano ob-"liquamente ad un modo nel ſeno, come non a tutte la membrana "interna del medeſimo ſomminiſtra quella valvuletta, che pure a mo' "di lingua, di briglia, di mezza luna frequentemente ne ottura la "metà, il terzo, o minor parte degli orifici." Malacarne, p. 94.

the

the ſame bodies which Ruyſch ſo frequently mentions as little particles of fat, and which others have taken to be the glands of the pia mater *. Vicq d'Azyr, in his xxxiiid plate, fig. 14, has confounded them under the name of the glandulæ Pacchioni †. Of theſe veins lying upon the ſurface of the brain, there is one, or very often there are two large veins on each ſide, and which enter generally pretty far back in the ſinus, and are ſomewhat peculiar from their greater ſize, and their ſemicircular courſe. Theſe, from their ſtate of dilatation, and the colour and fluidity of their blood, will be found in morbid diſſection, to mark ſufficiently, in many inſtances, the character of the venous ſyſtem of the brain. There is again another vein ſomewhat peculiar in its courſe: whilſt thoſe take a ſuperficial courſe, and are upon the level of the longitudinal ſinus, it gathers its branches upon the internal flat ſurface of the left hemiſphere, and riſes ſo as to inſinuate itſelf into the

* "Portio piæ matris in liquore, cujus ſuperficies exterior obſita "variis particulis prominentibus exiguis, quas pro glandulis habue- "runt nonnulli: cum autem ſint diverſæ formæ, et colore pinguidinem "repræſentent, pro pinguidine potius illas habeo præſertim cum "inter duplicaturam piæ matris aliquoties pinguidinem invenerim." Theſaurus Anat. ix. N°. xlii. Epiſt. ix. p. 8. Theſ. v. N°. 1.

† We ſee alſo what he ſays in the Acad. of Sciences, An. 1781, p. 502. "Elles étoient plus ou moins recouvertes, vers leur inſer- "tion par les glandules de Pacchioni; les ayant examinés dans pluſi- "eurs ſujets, j'ai obſervé qu'elles étoient a peu-pres, de chaque "côté au nombre de dix, douze, ou quinze." Ridley calls theſe "carnous adneſcences," betwixt the membranes, p. 8. As to the gland which Willis affirms to be ſcattered over the tunica arachnoides, I could never ſee them. Ridley.

the inferior part of the finus *. All thefe veins of the furface of the cerebrum have very free inofculations with each other.

I cannot any where better obferve the negligence of authors, in regard to the glandulæ Pacchioni, than when fpeaking of the mouths of thofe veins which open into the great longitudinal finus.

I cannot help thinking, that many of our beft authors have overlooked entirely the importance of the glandulæ Pacchioni; and many alfo have been entirely ignorant of them. We have already mentioned, that a few fmall bodies by no means conftant nor regular, were to be feen upon the external furface of the dura mater, in the courfe of the longitudinal finus, or at no great diftance from it. We have mentioned alfo thofe fatty-like adhefions of the roots of the veins as they enter the finus, and which rather belong to the pia mater. Both thefe are called the glandulæ Pacchioni improperly. The bodies which engaged Pacchioni and Fautonus in fuch violent difputes, are feen on the infide of the longitudinal finus, and are connected with the opening of the veins †; they

* Vicq d'Azyr.

† "In longitudinali finu, immediate, fub membranofis expanfioni- "bus, in areolis chordarum Willifianarum, quin et fupra eafdem chor- "das confitæ funt inumeræ glandulæ conglobatæ, propria, et tenuif- "fima membrana, veluti in facculo conclufæ; quæ racematim ut "plurimum coeunt; raro fparfim difponiuntur: hæ glandulæ utrin- "que ad latera falcis mefforiæ, ab ejufdem apice ad bafis ufque pof- "ticam partem miro prope modum artificio procedentes, dorfo la- "certorum accumbunt, & partim ab horum fibris, partim ab iis, "quæ a chordis emergunt, firmantur, atque invicem alligantur, ita "ut non nifi lacerat acu disjungi poffint." Vide Pacchioni, p. 126. "Sinu

An Accurate Copy of Pacchioni's Plate of the Glands.

Engrav'd by Fran.^s Lamb.

they appear of a flefhy colour, projecting like papillæ, or like the granulations of a fore. Pacchioni fays, "Ovorum inftar bombycinorum apparent," which defcribes their conglobate appearance; but they are of a pale flefhy colour, which Pacchioni fays is owing to their being furrounded with mufcular fibres. I have added the plate of Pacchioni, and contrafted it with a more natural drawing of them. The preparation from which Pacchioni had taken his plate, was previoufly macerated in vinegar. Thefe bodies being foft and vafcular, have allowed the minute injection to tranfude in fome of the experiments of anatomifts, which has given rife to the opinion of the actual communication of the arteries of the dura mater with the finufes. As to their ufe *, I am in confiderable doubt. Joan. Fautonus (in his letters to Pacchioni) conceives that they give out a fluid into the finus, to dilute the venous

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"Sinu longitudinali aperto, in confpectum veniunt corpufcula rotunda, & fubrotunda, milii forma, (a clariff. viro Pacchiono detecta) hæc magnitudinem aciculæ vulgaris caput haud fuperant, nifi per microfcopium introfpiciantur, aut ex duobus corpufculis combinentur." Ruyfch, Thef. vii. N°. xxxiv. From this we fee how various the fize of thefe bodies is. In the next paragraph he obferves, "Vix et ne vix quidem ullum ex dictis corpufculis videre poteft."

* It is curious that thefe bodies are confined to the longitudinal finus. "Mirum, & æque animadverfione dignum eft, hafce glandulas ad folius longitudinalis finus latera reperiri cum in lateralibus finubus vel nunquam, vel raro admodum per pauca earundem veftigia adnotentur, ubi præfertim præfati canales deorfum inclinare incipiunt, antequam ab interfeptorum dorfo difcedant." Pacchioni, p. 127.

blood,

blood *. Pacchioni defcribes ducts paffing from them to the pia mater, (which are thofe connections that we have already remarked,) and conceives that they lubricate the furface, or communicate with the fubftance of the brain; and that they are preffed, and their fecretion promoted by the motion of the chordæ Willifianæ, and the action of the dura mater †.

I fhould rather conceive that they had a valvular action on the mouths of the veins; they project from the mouths of the veins into the finus, and the blood paffing from the veins muft filter through them, and be checked in its retrograde courfe, and perhaps obftructed in its natural courfe when they are enlarged. As thefe bodies differ very much in the variety of fubjects, they muft fometimes impede the free egrefs of the blood from the veins of the cerebrum into the longitudinal finus, and caufe difeafe, efpecially as they are fofter and larger in old men ‡. At all events, they are too much overlooked in morbid diffection.

The veins which anfwer to the arteria corporis callofi,

* "Ego aqueum humorem in glandulis egregari, fluere lympham in tubulis, quos tecum lymphaticos appello, nunquam negaverim, fed liquidi fluxum ab utrifque verfus finum magis, quam verfus ambitum cerebri verifimilem, magifque naturæ legibus confonum effe affirmo." Fautonus Epift. D. A. Pacch. Oper. Pacch. 177.

† "Ex iis autem in minimum quidem vafculum lymphaticum prodire confpicere potui." Ruyfch.

‡ "Fibris carneis tenuiffimis circumambiuntur fingulæ, unde colorem carneo-pallidum nancifci videntur: in fenibus vero, in quibus hujufmodi fibræ enervatæ nimis laxantur, et ferme difparent, glandulæ albefcentes, & magis turgidæ cernuntur: quod, & in hydrocephalicis, comatofis, & id genus aliis obfervari poffe arbitrarer." Pacchioni Oper. p. 126, 127.

and

and which are ſeen lying upon the corpus calloſum in a very fine cellular membrane, riſe and paſs into the inferior longitudinal ſinus, that which is formed in the lamina of the inferior edge of the falx.

OF THE INTERNAL VEINS OF THE BRAIN, AND OF THE CHOROID PLEXUS.

Under this title of the internal veins of the brain, the the choroid plexus comes naturally to be conſidered.

the Choroid Plexus & Vena Galeni taken from the Brain & Spread so as to Show their Connection

1 Choroid Plexus of the right Side 2 Plexus of the left Side Spread out 3 Arteries to this part where it lies in the inferior horn 4 Plexus of the 3d Ventricle formed by the Junction of 1, 2. 5. Vena Galenii

D. Lizars, Sculp.

The moſt remarkable thing in the ventricles of the brain is, that they have lying in them this very peculiar vaſcular ſtructure, the choroid plexus. The lining membrane of theſe cavities is extremely thin and ſmooth, inſo-

insomuch, that some anatomists have denied its existence; but through the whole ventricle there run certain folds or plaits of this membrane, which are so loaded with vessels as to resemble a fleshy substance, and to lose altogether their resemblance of the lining membrane. The plaits, before they are unravelled, look like masses of tortuous vessels, lying loose and unconnected in the bottom of the ventricles.

The largest portion of each plexus choroides comes up from the posterior prolongation of the lateral ventricles; they then run forwards. In each ventricle they lie in the groove, betwixt the thalamus nervi optici and corpus streatum; and cover the tenia semicircularis geminum. These two plexus of the lateral ventricles unite under the anterior crus of the fornix, and form a small plexus, which is continued upon the inferior surface of the velum interpositum, and even into the third ventricle. Again, there is a plexus which lies in the fourth ventricle. Vicq d'Azyr also describes, as occasionally occuring, little insulated plexus attached to the veins, branching on the corpora streata*. Thus each division of the brain has its choroid plexus.

These vascular webs must have an important use. I should conceive that they chiefly secreted the fluids of the ventricle; for I believe the tortuosity to be the most unequivocal mark of the activity of its vessels.

* "Sur le côté des ventricules latéraux, j'ai quelquefois observé de "petits plexus choroides isolés, que accompagnoient quelquesuns "de ces rameaux des veins de Galien, que l'on voit passer sous le "tænia semicircularis, & s'etendra sur le corps strié." Vicq d'Azyr Memoir. l'Acad. Roy. 1781, p. 540.

This

This opinion, however, is nothing new *. Another prevailing idea was, that the blood accumulated in these convoluted vessels occasioned such a gentle continued heat as favoured the circulation of the spirits through the cavities of the brain, and preserved the fluidity of the water of the ventricle †. Great variety of opinions have prevailed regarding the structure of those bodies. We see them consisting of knots of convoluted vessels; chiefly veins; or these at least are most evident from their size, and the colour of their blood. These convolutions of vessels are by many good anatomists described as glands. Varolius, Sylvius, Wharthon, Willis, Santorini, and Lieutaud, consider them as such ‡. Three

* The supposed glands of the plexus choroides were conceived to secrete the fluid of the ventricles. Where the plexus lies upon the posterior crura of the fornix, it is often diseased, having knots like glands, or, being raised into vesicles, like hydatids. "Eas bullas "humorem ventriculorum secernere olim conjectura fuit. Verum "vitio cum nascantur vix perpetuum habitum generare idoneæ erunt." Haller, tom iv. 48.

† See Duverney, tom i. p. 55. "Ut enim sanguis intra sinuum "cavitates aggestus, Balnei calidioris vicem prestat, quo spiritus ani-"males in extima & corticali cerebri parte uberius distillentur: ita "sanguis intra plexus hujus vasa exilia contentus, quo iidem spiri-"tus in penitiori ac medullari substantia idonee circulentur, Balnei "minoris, & magis temperati loco esse videtur." Willis Cerebri Anat. p. 47.

‡ Galen gives a good description of the choroid plexus; he describes the innumerable veins of which it is composed, and their joining the fourth sinus by the vein which retains his name. Some have confused themselves with a passage of Ruysch, Thes. iii. No. lxv, &c. in which he is speaking of the choroid plexus, where it appears in the base of the scull, from the bottom of the fourth ventricle. They have understood him to say, that the plexus was covered not with the pia mater, but with the tunica arachnoides.

 sets

ſets of ARTERIES paſs up to the PLEXUS CHOROIDES, from the baſe betwixt the crura of the brain; they come, 1ſt, from the curve of the internal carotid artery; 2d, from the communication betwixt the baſilar and carotid artery; 3d, from the baſilar artery, and moſt poſterior part of the branch of communication. Theſe arteries, which are ſmall, are convoluted into great minuteneſs * in the membrane, and their blood is returned by veins, which taking a very tortuous courſe, ſeem to entangle their branches, and form a meſh of veins.

The blood of the two plexus of the lateral ventricles, and that of the third, is conveyed into the velum interpoſitum, or that membrane which ſtretches under the fornix, and over the third ventricle. The branches of veins alſo which extend themſelves upon the ſides of the lateral ventricles, and into the proceſſus digitalis, being gathered together upon this membrane, open into the vena galeni, or rather form it.

The moſt remarkable branches of veins in the lateral ventricle are theſe: A conſiderable branch is ſeen to collect its branches upon the anterior part of the ventricle, and in the anterior ſinus, or horn of the ventricle. This vein runs back towards the anterior crus of the fornix, and dips under it, juſt above the communication of the ventricles; and joins the veins in the velum of Haller. Other ſmall veins are ſeen collecting their branches upon the corpora ſtriata; and, paſſing under the centrum ſemi-circulare geminum, connect

* "Huncce plexum nil eſſe niſi arteriolas, ad viſum ſuccoſas, a "naturali conſtitutione arterioſa non nihil recedentes, mirumque in "modum contortas, ſerpentinoque modo reptantes, glandulaſque "repreſentantes." Ruyſch, Theſ.v. Aſſer. quartus N°. lxviii. Not. 2.

 them-

themſelves with the plexus. Again ſeveral branches of veins are extended in the poſterior part of the ventricle. Theſe are from the medullary ſubſtance of the poſterior lobe of the cerebrum. They paſs under the poſterior crus of the fornix and join the vena galeni. Laſtly a vein remarkably tortuous, frequently full of blood, paſſes forward and is ſeen at intervals in the plexus choroides. This vein taking an acute turn, joins its fellow under the anterior crura of the fornix and is reflected backwards and under the fornix, ſo as to form the beginning of the vena galeni.

The VENA GALENI then is the great central vein of the brain. It ſtretches from the extremity of the fourth ſinus into the internal part of the brain, to receive the blood from the membrane lining the ventricles,—from the ſubſtance of the brain,—from the plexus choroides,—and from the velum interpoſitum*. It lies under the poſterior part of the corpus calloſum, under the fornix and above the nates and teſtes. It is entangled in the velum itſelf. It conſiſts of two great branches which lie parallel to each other, and which ſometimes have the appearance of being twiſted, and theſe unite before they enter the fourth or ſtraight ſinus.

In the BASIS of the BRAIN the veins are not remarkable nor do they require any deſcription diſtinct from the ſinuſes into which they open.

* The velum lying upon the nates and teſtes, and adhering to them and the pineal gland, the vena galeni receives here alſo veins from thoſe bodies, and from the upper part of the cerebellum.

They are ſmall, having little way to run; and before they become large trunks, they empty themſelves into the numerous leſſer ſinuſes betwixt the dura mater and baſe of the ſcull. This is perhaps a proviſion againſt the preſſure of the brain. In paſſing into thoſe ſinuſes, the veins take a long oblique courſe betwixt the lamellæ of the dura mater; which has given occaſion to anatomiſts to deſcribe many intricate leſſer ſinuſes.

OF THE PARTICULAR SINUSES.

Although by the term ſinus we are to underſtand the great veins of the brain, yet as having ſome circumſtances peculiar to them it is well to diſtinguiſh them by a diſtinct appellation.

SUPERIOR LONGITUDINAL SINUS.

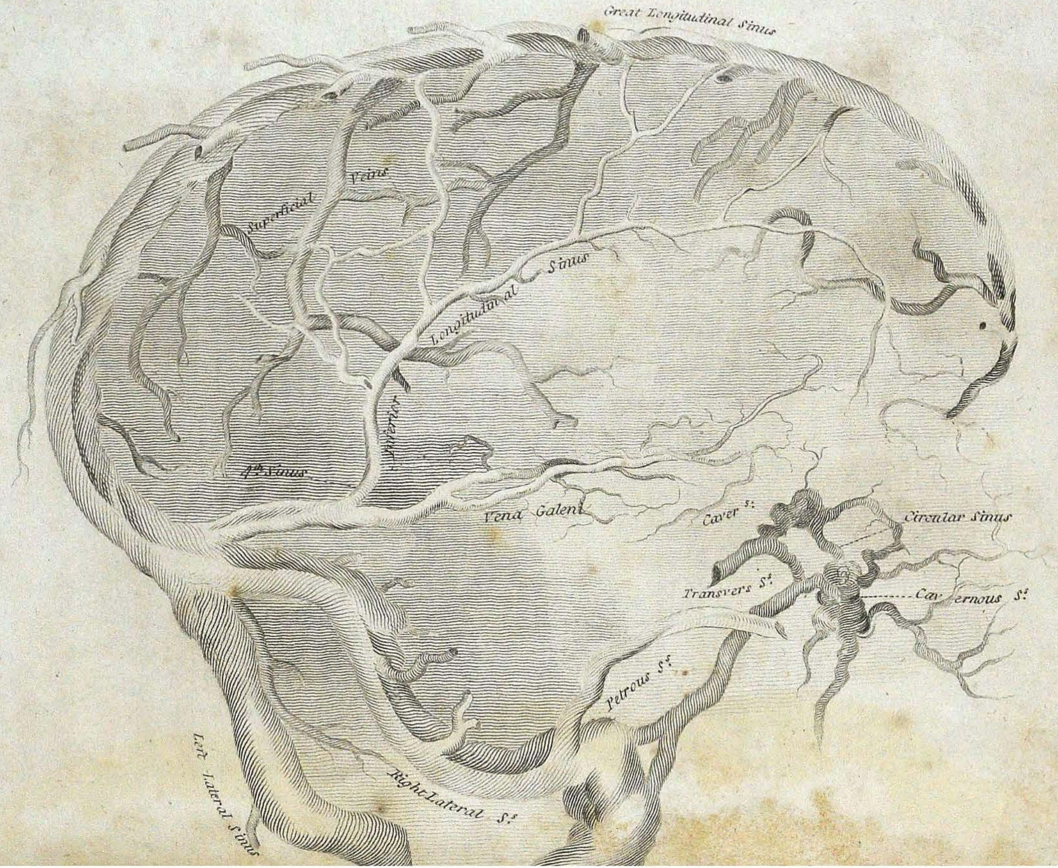
This is a triangular channel, running in the falx from the criſta galli of the æthmoid bone to the crucial ridge of the occipital bone. It is not conſtant in its origin. Sometimes it begins from a blind foramen before the criſta galli*. Sometimes from the orbital ſinus†. In ſome ſubjects it begins only oppoſite to the fontanelle, or even further back, and then at once ſwells out to a large ſize.

As

* Malacarne, Haller, Gautier.

† Theſe ſinuſes as frequently are continued into the inferior longitudinal ſinus or into the circular or eliptical ſinus; they are like azure ſtreaks under the dura mater, covering the orbital proceſs. "Molti fra i voti biſlunghi, ovali, tondi, irregulari, che ſi vidono all', "angolo inferior del ſono L. S. Sono caverne cieche o le une colle "altra

Plan of the Sinuses



As the ſinus paſſes backwards it is gradually enlarging for the reception of the veins from the ſurface of the cerebrum. As we have already demonſtrated by the marginal plate of the ſection of the longitudinal ſinus (page 52), the baſe of the angle is curved, anſwering to a ſulcus, which runs in all the length of the cranium, from the æthmoid bone to the crucial ridge of the occipital bone. The lateral planes are drawn tenſe and converge into an accute point; the angle formed by the ſplitting of the internal layers of the dura mater, is ſtrengthened by ſtrong ſlips of fibres, which upon the inſide of the ſinus have the effect of making it irregular, and in ſome degree having the appearance of cells, into ſome of which cells the probe enters, and leads to the veins on the ſurface of the brain; others are blind, or lead to leſſer ſinuſes, which not unfrequently run parallel for ſome length to the great ſinus; or the probe paſſes from one of theſe cells to another. Sometimes, however, the ſinus has no ſuch irregularities, but is ſtraight and ſmooth through its whole length *.

"altre communicanti laſciate dai gia deſcritti faſci della fibroſa, "ſenza che ad eſſe giunga vaſo aliuno." Malacarne, p. 94.

"Hæ cellulæ ab expoſito ſinu ad verticem uſque, uberiores, "atque magis amplæ perſpiciuntur, et inequaliter hinc inde locantur; "ipſarum plurimæ vacuæ ſunt habentque orificia in oppoſitas quaſi "partes hiantia; membrania circumteguntur quæ eſt inſtar valvulæ "ſemilunaris, totam tamen cavitatem non occludentis; reliquæ vero "faveolas tantummodo impervias repreſentant." Pacchioni, p. 124.

* The internal membrane of the ſinus is perfectly ſmooth, and is continued into the coats of the internal jugular veins; it is of the ſame nature with the internal coat of the vein.

This ſinus has in ſome rare inſtances been found of a ſquare ſhape; its lower ſurface ſerving as a roof for another ſinus of a triangular form, which, for ſome way, runs parallel with the great ſinus, and which was of courſe alſo included in the lamina of the falx—theſe Malacarne calls ſeni ſubalterni. Irregular leſſer ſinuſes are by no means uncommon, and they form, ſometimes, communications through a great extent of the longitudinal ſinus; or again it will be found that the longitudinal ſinus deviates conſiderably, in ſome ſubjects, from the ſtraight line, taking a curve or circle, generally behind the fontanelle; or it ſends off branches, which again unite with it; or it is fairly divided. In all theſe caſes the chords or faſciculi of the dura mater ſtretch out over the ſinuſes, and protect them from compreſſion.

Inſtead of reaching backwards to the crucial line upon the occipital bone, the longitudinal ſinus has been found to divide at the beginning of the lambdoidal ſuture, and to follow them in a direction towards the petrous bone * while the lateral ſinuſes, running in the duplicature of the tentorium, were reduced to a very narrow compaſs.

From the ſtrength of the connections of the ſinuſes, and from the languid courſe of the blood through them, I ſcarcely believe that the ſinus has ever ſuffered the diſtention, which Malacarne deſcribes in ſome caſes. I ſhould rather ſuppoſe that what he mentions had been natural and congenital enlargements; eſpecially con-

* Malacarne, part i. 148.

ſidering

fidering that the finufes, like the other veins of the body, are very apt to be irregular.

LATERAL SINUSES, OR THE FIRST AND SECOND OF THE ANCIENTS.

The lateral finufes are formed by the fplitting of the lamina of the tentorium, as the longitudinal finus is by that of the falx. From the crucial ridge of the occipital bone they ftretch nearly horizontally; following the connections of the tentorium in a direction toward the petrous bone; then they take a curve downwards and forwards, to terminate in the internal jugular vein; paffing through the foramen lacerum of the temporal and occipital bones.

Very frequently the one lateral finus is larger than the other—generally the right is the larger, and fometimes the left is entirely wanting *.

They diverge from the termination of the fuperior longitudinal finus at the crucial point of the occipital bone: but fometimes they are irregular, diverging higher, and even paffing round in the circle of the pofterior part of the cranium, at fome diftance from the tentorium †.

The right lateral finus for the moft part begins higher than the left. It is generally longer, and may be confidered as the continuation of the longitudinal finus. Nay, in fome fubjects, the right or left lateral finus begin from the longitudinal one, while that of the other fide is continued from the fourth, or the tor-

* Lieutaud Anat. Hift.

† Malacarne.

cular hierophili; and the lateral ſinuſes are ſeparated at their origin by a membraneous iſthmus—if it ſhould happen that the left lateral ſinus receives the ſuperior longitudinal one, it would be found to be four times the ſize of the right; ſometimes, alſo, the longitudinal ſinus, turning to the right, is continued into the ſinus of that ſide; and the left lateral ſinus opens or begins by two or more irregular holes *.

I have ſeen a more remarkable variety of the lateral ſinuſes. The blood which ſhould flow from all thoſe parts of the brain from which the ſuperior and inferior longitudinal ſinus, and the vena Galeni, and fourth ſinus are derived, ſeemed, inſtead of paſſing by the root of the tentorium, to have forſaken theſe channels; the lateral ſinuſes were left diminutive; and the blood had taken a courſe in the tract of the poſterior occipital ſinuſes, and, after incircling the foramen magnum, it gained its uſual outlet †.

The angles of the lateral ſinuſes are ſtrengthened by membraneous faſciculi; which paſs radiated from point to point, or are confuſedly intricated; betwixt theſe the veins enter as in the longitudinal ſinus; where the ſinus deſcends from the level of the tentorium in the angle formed by the occipital and petrous bones, there are many ſtrong irregular faſciculi of fibres: under this point, being no longer protected from compreſſion, by their triangular ſhape and the tenſion of the tentorium, the ſinuſes are irregular; they are now ſunk in the

* See Morgagni Adverſaria VI. tab. i. fig. 1.

† There are inſtances of the lateral ſinuſes opening into the external jugular vein.

ſulci

ſulci of the bones, and the dura mater ſpreads its ſheath over them.

The great irregular cavity *, in which the extremities of the lateral ſinuſes lie †, and the foramen lacerum have much variety, and their ſtraightneſs ſeems to affect the ſize of the ſinus in its whole length ‡.

OF THE INFERIOR LONGITUDINAL SINUS.

The inferior longitudinal ſinus, or ſimply the leſſer, or inferior ſinus of the falx, runs in that edge of the falx which penetrates betwixt the hemiſpheres of the cerebrum. It is extremely ſmall towards the fore part of the falx; but, as it paſſes backwards, it goes on increaſing by the acceſſion of veins which come from the hemiſpheres, and corpus calloſum, and from the falx itſelf. It is formed betwixt the lamina of the falx. Sometimes it runs in its very edge, but as frequently a little way removed from it; ſometimes it is found beginning very far back in the falx. The fore part of it is more like a vein running in the falx than a ſinus. It is in general to be ſeen more ſuperficial, and in every reſpect like a vein, (there being no proviſion for

* Lower conceives that the ſize of the jugular foſſa was the effect of the reflux of the blood; and that the greater ſize of the ſinus of the right ſide was to be traced to the practice of nurſes laying their children chiefly on the right ſide! See alſo Morgagni Adverſaria Anat.

† See Willis Anatom. Cereb. Hum. p. 29, and the plate.

‡ Some very large veins open into the lateral ſinus; they are derived from the poſterior lobes of the cerebrum and the cerebellum. Theſe inſinuating irregularly betwixt the lamina of the tentorium, and running for ſome way, have been conſidered as additional ſinuſes. See Haller, tom. iv. p. 149.

preſerving

preferving it from compreffion) upon one fide of the falx. It very often takes a waving courfe upon the falx; while it receives veins, which branch in the fubftance of the falx, and form communications betwixt it and the fuperior longitudinal finus. It opens into the ftraight or internal finus, near the edge of the tentorium.

OF THE INTERNAL, STRAIGHT, OR FOURTH SINUS *.

I would call this the internal finus, from its fituation, but more particularly from its receiving the veins from the internal part of the brain. This finus is formed chiefly by the vena galeni; which, coming out from betwixt the corpus collofum and tuberculi quadrigemini, enters betwixt the lamina of the middle part of the tentorium, where it is united to the falx; fo that by the tenfion of thefe two partitions this finus is drawn into a triangular form, and is as incompreffible as thofe finufes which run connected with the bone.

It opens, for the moft part, by an oval mouth, formed by ftrong pillars of fibres, into the left lateral finus, rather than directly in the middle of the communication of the three great finufes. We fhall find this like the other finufes fuffering confiderable variety; or irregular fmaller finufes will often be found running betwixt the lamina of the tentorium.

* Sinus quartus, Perpendicularis. Haller—The fourth finus; the two lateral being the firft and fecond, and the longitudinal being the third finus.

POSTERIOR OCCIPITAL SINUSES.

These are so called in opposition to some irregular and small sinuses, which run upon the occipital bone before the great foramen. THE POSTERIOR OCCIPITAL SINUS lies in the little falx of the cerebellum; it rises upwards, and opens into the common union of the longitudinal and lateral sinuses; it commonly, however, lies rather to the left, and empties itself into the left lateral sinus. It is by no means * constant; like the other lesser sinuses it is subject to great variety; and, before it rises into the tentorium, or empties itself into the larger sinuses, it has a communication or emissarium, by which part of the blood may pass into the external veins, through a foramen in the centre of the occipital bone †.

THE INFERIOR LATERAL SINUSES.

The inferior lateral sinuses are still more rarely to be found than the last, in so much that Vicq d' Azyr says he never has seen them. They run in the lamina, or under the dura mater, of the posterior fossa of the base of the scull; that is the hollow of the occipital bone, which is under the tentorium. They are so irregular that they frequently occur in one or other side only. They communicate with the posterior part

* Vicq d'Azyr.

† Malacarne.—This sinus is sometimes double; or it has two branches encircling the posterior margine of the occipital hole; or, as I have already observed, it takes the office of the great superior lateral sinuses, and empties it into the foramina lacera; or they communicate with the vertibral veins. See Observations sur un dilatation singulière des sinus occipitaux, Mem. de l'Acad. Roy. Anno 1781, p. 596.

of

of the foramen lacerum; with the posterior petrous sinus or vertebral veins; or lastly they occur as an irregular collection of channels running in the several neighbouring sinuosities *.

We see then that there is a point of union for all these sinuses, which we have not as yet described: we see that the superior longitudinal sinus, the two lateral sinuses, the fourth (and consequently the inferior longitudinal sinus), and the posterior occipital sinus, unite at the crucial spine of the occipital bone. This is the torcular hierophili †, torcular, lacuna, platea, tertia vena, palmentum, pelvis, laguncula. It was natural that the attention of the ancients should be drawn to this part; for, upon opening this union of the sinuses, we find a large irregular cavity, which seems to be particularly strengthened by these strong fasciculi of fibres, which form the support of the sinuses ‡. Ignorant of the circulation, imagining that the blood ascended by the great jugular veins to the lateral sinus, and seeing that the lateral sinuses opened into this central cavity, they conceived that the blood

* "Independente dai seni lateralia inferiori ho veduta tra le robuste "lamine e le fibre, dalle quali incomincia crassissimo l'imbuto verte-"brale intorno al maggior foro del cranio una quantita di caverne, di "cellule communicanti insieme, le quali formavano un seno circolare "irregolarissimo appoggiato sulla parte superiore, o sia sul margine "interno del foro medesimo." Malacarne, p. 113, 114.

† Herophilus was a Greek physician, a disciple of Praxagoras, and cotemporary with Erasistratus.

‡ "Deinde et illia per sectionem scalpellum injiciens, sursum "adigere conoberis ad usque verticem ubi venæ duæ invicem congre-"diuntur; quam regionem Herophilus nominat lenon, torcular "Galen. Lib. Nonus de Cerebri, &c. Dissectione."

destined for the brain underwent an operation there, and was thence sent through every part of the brain *.

OF THE LESSER SINUSES IN THE BASE OF THE SCULL.

Besides those larger sinuses which we have described, and which convey back the great proportion of blood circulating in the brain, there is a set of lesser sinuses which lurk betwixt the dura mater and the anterior part of the base of the scull. These last are fully more intricate than the others; they lie upon the irregular surface of the sphenoid, temporal, and occipital bones; and tend backwards to the great embouchoir formed by the irregular hole in the temporal and occipital bones.

THE SPHENOIDAL SINUSES.

The SUPERIOR SPHENOIDAL SINUSES are seated in a fold of the dura mater, on the internal margin of the

* "Coeuntes autem in vertice capitis, quæ sanguinem deducunt "meningis duplicaturæ, in locum quendam vacuum quasi cisternam "(quem sane ob idipsum Herophilus torcular solet nominare,) inde velut "ab arce quadam omnibus subjectis partibus rivos mittunt; quorum "numerum nemo facile dixerit, quod partium nutriendarum numerus "sit infinitus. Manant autem rivorum nonulli quidem ex medio ipso "loco in totum cerebellum, secti, ac derivati, eodem prorsus modo, "quo ii qui in areolis, alii autem ex parte anteriore feruntur, ea "scilicet qua torcular excipit dixeris utique velut rivum quendam "sanguinis, quem et ipsum ex crassa meninge admodum ingeniose "fabricata est, partibus enim ipsius meningis quæ sanguinem "duxerunt ad torcular appulsis, dimissaque illinc aliqua in partes "subjectas, non amplius, quod superarat, uni venæ concredidit, sed "preterea ex crassæ meningis partibus anterioribus extensis rivulum "efficit, ex quo primum multos rivulos per totam viam produxit." Galen, cap. vi. *de torcular. Et quo pacto venæ intra cerebrum distribuantur.*

wing

wing of Ingraſſias, and before the great wing of the ſphenoid bone; they receive the blood in part from the orbit, and from the dura mater; they open into the cavernous ſinus, or perhaps into the opthalmic ſinus, which of courſe, for the moſt part, conveys the blood into the ſuperior or inferior longitudinal ſinus.

The INFERIOR SPHENOIDAL SINUS is very irregular and inconſtant. It is in the dura mater, covering the great wing of the ſphenoidal bone: the blood of this ſinus is emptied into the cavernous ſinus, or eſcapes by emeſſarii into the trunk of the temporal veins.

The ANTERIOR CLYNOID SINUS.—The poſterior clynoid ſinus, or eliptic ſinus, and the circular ſinus, are one and the ſame; the difference conſiſts only in the manner of deſcribing them; the CIRCULAR SINUS lies within the clynoid proceſſes of the ſphenoid bone, and ſurrounds the glandula pituitaria *.

As this circular ſinus opens upon each ſide into the cavernous ſinus, it is not unaptly divided into two; the anterior half of the circle, being the anterior

* Ridley deſcribes it in theſe words: "Another I diſcovered by "having injected the veins with wax, running round the *pituitary* "*gland* on its upper ſide, forewardly within a duplicature of the "dura mater, backwardly between the dura mater and pia mater, "there ſomewhat looſely ſtretched over the ſubjacent gland itſelf, "and laterally in a ſort of canal made up of the dura mater above, "and the carotid artery on each outſide of the gland, which, by "being faſtened to the dura mater, above and below, at the baſis of "the ſcull, leaves only a little interſtice betwixt itſelf and the gland." (Accuratius tamen a Rilleyo deſcriptus eſt. Haller.)

But Ridley is aſſuming merit to himſelf. Brunnerus deſcribes this ſinus.

clynoid

clynoid ſinus of ſome author; the poſterior half (which is in general wider), the eliptical or poſterior clynoid ſinus, or ſemilunar.

This ſinus, like moſt of the leſſer ſinuſes, is irregular in its ſhape, its ſize, its communications, and its origin *. Its natural communication is with the cavernous ſinus, which in fact encroaches upon its ſide; it will be found to communicate alſo with the ſphenoidal ſinuſes, and the obliqui or petrous ſinuſes †: at one time the anterior half of the circle is wanting; at another the poſterior ‡.

THE CAVERNOUS SINUS.

The cavernous ſinus is a great irregular centre of communication with the leſſer ſinuſes in the baſe of the ſcull. This ſinus is ſunk upon each ſide of the ſella turcica, and is formed in the irregular ſplitting of the lamella of the dura mater: it is of a triangular ſhape; it extends from the ſides of the ſella turcica, even to the foramen ſpinali §. The pointed extremity of the tentorium, which extends forwards from the angle of the petrous bone to the poſterior clynoid proceſs, covers and protects it. The cavernous ſinus is different

* "Varie ſono le origini, e le foci di queſto ſeno. Alcune volte il "fondo della foſſa pituitaria vi invia due canaletti longitudinali, "che ſcorrono ſul dorſo di quelle due pieghe ſottili falcate ond-iè "tripartita la glandula pituitaria. Altre volte la foſſa diviſa per "traverſo da una ſimil piega che pure ha ſul dorſo il ſuo ſeno, "allo elittico lo invia." Malacarne, p. 123.

† Haller, tom. iv. p. 154.

‡ "Nunc anterior nunc poſterior ejus arcus amplior eſt; nunc anterior nunc poſterior ejus arcus deficit; nunc totus ipſi deſideratur; "interdum vere duplicem fuiſſe, referunt." Sommerring, vol. v. p. 354.

§ Malacarne.

from

from all the others; it is an irregular cavity, full of fibrous cords traverſing it, which gives it a kind of cellular appearance. It is like a diſeaſed part into which the blood had been driven, till the cellular texture had been diſtended and partly deſtroyed. After a minute injection, ſmall arteries are ſeen to ramify among theſe fibres; the internal carotid artery riſes through it, and the ſixth pair of nerves is involved in it, in their paſſage from the ſcull.

This ſinus is the centre of the little ſinuſes and veins of the anterior part of the baſe of the brain and cranium: four or five veins pour their blood into it, from the anterior lobes of the brain and the foſſa ſilvii; ſometimes, even the opthalmic veins open into this receptacle*. The ſuperior and inferior petrous ſinuſes, and the baſilar ſinus, open into it behind; the circular before; the ſphenoidal ſinuſes and veins of the dura mater upon the ſide; while the right and left ſinuſes often communicate by means of the tranſverſe ſinus. Beſides theſe the petrous ſinuſes have ſeveral communications, or emiſſaria as they are called, viz. by the inferior maxillary foramen, the funnel of the carotid artery, through which deſcends a vein, (the vena ſodalis arteriæ carotidæ,) which terminates in the pterigoid plexus of veins, the ſphenoidal fiſſure, the interoſſeous ſinus of Malacarne †.

* This vein, the vena angolana, makes a very remarkable emiſſaria, but it is more probable that the blood in ſuch veins runs inwards than that it eſcapes from the ſcull to the external veins.—Cum venis poſterioribus frequentes nexus init. Sommerring, vol. v. p. 354.

† The Emiſſaria, 4ta. of Tabarini. Obſerv. Anatom. p. 42, et. ſeq.

The

The TRANSVERSE, or POSTERIOR CLYNOID SINUS, runs acroſs from one oblique ſinus to another behind the poſterior clynoid proceſſes *. In its form it is not peculiar, nor is it very regular.

There are two PETROUS SINUSES, the anterior and poſterior, or the inferior and ſuperior ſinuſes; theſe two come off nearly together from the carvernous ſinus, and running back upon the petrous bone, terminate in the lateral ſinuſes or beginning of the internal jugular vein; but which two to take as petrous ſinuſes is a queſtion. For example, Malacarne ſhows that there is a ſinus, by no means uncommon, which belongs as ſtrictly as thoſe others to the petrous portion of the temporal bone.

He calls this new ſinus the anterior petrous ſinus; and the ſuperior of other writers, he calls the poſterior petrous ſinus; and the inferior petrous ſinus of other writers, as it lies more upon the cuneiform apophyſis of the occipital bone, and runs ſlantingly, he calls the oblique. I would on the contrary conſider two of theſe as the petrous ſinuſes; the oblique ſinuſes of Malacarne, as the lateral baſilar ſinuſes; and thoſe which run on the middle of the cuneiform apophyſis, as the middle baſilar ſinuſes.

The ANTERIOR PETROUS SINUS runs upon the anterior face of the petrous bone, from near the ſpinal hole †; whence, making a ſemicircular curve in

* In truth the ſuperior, and inferior, or oblique ſinus, the cavernous, and the tranſverſe, meet nearly at a point.

† And here it has a tranſverſe branch of communication with the cavernous ſinus, which runs under the extended point of the tentorium.

the angle of the petrous and ſquamous portions of the temporal bone, it terminates in the lateral ſinus.

The POSTERIOR PETROUS SINUS * lies in that pointed extremity of the tentorium, which ſtretches forward, connected with the acute angle of the petrous bone. It is narrow; and a ſulcus or groove on the angle of the bone gives a partial lodgement to it; it paſſes from the cavernous ſinus to the great lateral ſinus.

The LATERAL BASILAR SINUS † is ſhorter and larger than the laſt; and it makes an oblique curve from the cavernous ſinus under the pointed extremity of the tentorium, which is continued by the ſide of the ſella turcica, to the termination of the lateral ſinus, or rather into the beginning of the jugular vein, by a channel, ſeparated by a boney lamina from the termination of the lateral ſinus; or it is continued into a vein in the baſe of the cranium, which afterwards joins the great jugular vein.

The MIDDLE BASILAR SINUS. This ſcarcely deſerves the name of ſinus. It conſiſts, in general, of a few cellular-like communications, formed in ſtrong fibres of the dura mater, which here partakes of the nature of a ligament. Theſe open into the laſt-mentioned ſinus, or ſometimes into the vertebral ſinus.

The VERTEBRAL SINUSES are veins included in the lamellæ of the dura mater; and, divided into right and left,

* Or ſuperior petrous ſinus. Vicq. d'Azyr.

† The inferior petrous, or oblique ſinus.

left; they defcend into the tube of the vertebræ, on its forepart, and pafs down even to the facrum. They are connected in all their length with the vertebral, dorfal, and lumbar veins. Thefe finufes, or veins, at each vertebræ, are joined by a tranfverfe branch; they are connected at the top of the fpine with the bafilar or anterior occipital finufes, and with the foffa of the jugular vein.

EMISSARIA SANTORINI.

"Venæ Emiffariæ" is but another name for thofe leffer veins which form a communication between the finufes within the head, and the external veins in the bafe of the cranium. Thefe, then, are chiefly the opthalmic *, maftoidean, and vertebral veins. But the vena fodalis, arteriæ carotidæ, the fmall vein which penetrates the parietal bone by the fide of the fagittal future, even the venæ arteriæ meningeæ fodales, and the little veins which pafs with fome of the nerves, or through the fiffures of the bone, are alfo brought into account. To thefe a much greater importance has been attached than they merit; particularly in apoplectic affections of the head, they are fuppofed to be eminently ufeful in emptying the fur-

* "Je me fuis convainçu, par des diffections multipliées, que les "finus caverneux & orbitaires communiquent, par un plus grand nom- "bre de veinules, avec les arrières-narines, de forte que les hémorrha- "gies critiques qui fe font par les nez, dans les fièvres aiguës, où la "tête eft affectée, s'expliquent facilement par ce moyen," &c. Vicq. d'Azyr, Acad. Royale, 1781, p. 504.

charged ſinuſes and veins of the brain into the external veins.

But thoſe leſſer paſſages for the blood, ſuppoſing us to be aſſured that the blood flowed through them, from the ſinus to the external veins, are inſignificant, when compared with the great out-let of the INTERNAL JUGULAR VEIN; to which we have ſeen all the ſinuſes tend. But the accumulation of blood in the veſſels of the brain is ſeldom mechanically produced; it is a diſeaſe in the action of the ſyſtem of the brain, to which we become more and more liable as we advance in years: it is the ſame gradual change which is operating on the venous ſyſtem from infancy to old age, that cauſes this claſs of diſeaſes of the brain to be peculiar to advanced life.

The importance of the ſinuſes in the circulation of the blood in the brain, is either vaguely deſcribed, or imperfectly underſtood by authors. We find it ſaid, that the ſinuſes ſupport the blood againſt compreſſion, and protect its free circulation. This to me ſeems an erroneous idea. The leſſer veins are, as in other parts of the body, and have no ſuch proviſion; and ſince, within the head, there can be no ſuch partial compreſſion as in the limbs, any cauſe which would compreſs the greater veins, were they not ſupported, muſt fall upon their extremities with worſe effect. The circulation is the only power which can act mechanically upon the brain; but this can never cauſe a compreſſion of its veins, becauſe the increaſed action of the arteries muſt tend more to the diſtention of the veins than it will be the occaſion of the brain compreſſing them.

 The

The more general idea conceived of the uſe of the ſinuſes is nearer the truth; *viz.* to prevent the ſudden and violent action of the muſcles of reſpiration, or of the muſcles of the head and neck, from repelling the blood into the vena cava, or internal jugular veins; and conſequently preventing the impulſe from being communicated to the blood in the ſmall and tender veins of the brain, which might endanger a rupture of them*. Yet this is not exactly the manner in which the ſinuſes preſerve the leſſer veins; they do not ſuffocate nor take off the force of the impulſe from the regurgitating blood, ſo much as they would do if they were like the trunks of veins in other parts; becauſe, being incapable of diſtention, they throw the undulation of the blood, when it is thus checked in its exit, backwards upon the extremities of the veins. But then the effect is, that no particular vein or trunk receives the ſhock; all ſuffer in a leſſer degree, and equally, which is their ſafety. All the veins in the baſe of the brain, which would be liable to rupture, or diſtention, from receiving, in their ſudden turns, the ſhock of the blood, checked by the muſcles of reſpiration, or otherwiſe, are preſerved by being incloſed in ſinuſes, and covered by the ſtrong lamellæ of the dura mater. The leſſer veſſels again are removed from the ſhock: its force is ſpent, becauſe it has ſpread among many branches; and it has become a general impulſe upon the brain, which the brain reſiſts, becauſe it is incompreſſible.

* Monro, Nervous Syſtem, p. 4.

That the brain does receive ſuch an impulſe, in violent coughing and ſtraining, is ſufficiently evident from the riſing of its ſurface on theſe occaſions, when it is accidentally laid open by fracture, or the trepan *.

Although the obſtruction of the jugular veins were to cauſe no regurgitation of the blood; although the ſinuſes were ſuppoſed to have an effect in preventing the diſtention of the veins, or return of the blood to the head; ſtill one effect of the continued action of the arteries is, to increaſe the plethoric ſtate of the brain, when there is a ſtagnation, or more or leſs remora, of the blood in the ſinuſes; and thence it is, that in every interruption to the free exit of the blood, the diſtention muſt ultimately fall upon the extreme veſſels†.

* The older phyſicians, obſerving the connection betwixt the motion of reſpiration and of the brain, conceived that the air was drawn through the noſe and crebriform bone into the brain, ſo as to diſtend it. Upon this hypotheſis followed many wonderful caſes.

We have already mentioned the hypotheſis which ſuppoſed compreſſion and relaxation of the cerebrum and cerebellum alternately, by the action of the falx and tentorium.

† We ſhall ſay that theſe veſſels cannot ſuffer diſtention, unleſs there be ſpace given for their inordinate dilatation, by blood proportionally ſent out from the cranium. But there is a degree of diſtention upon them, a tenſion which cannot be relieved, nor the contraction of the arteries allowed. The impulſe from the heart and arteries is ſtill continued, and is increaſing the evil. Bleeding here relieves this action, and diminiſhes the danger; and by this means we can ſuit the activity of the veſſels entering the brain, to the temporary remora in thoſe which convey the blood out of the head.

We

We ought not to confound the idea of incompreſſibility of the brain with that of a ſolid ſubſtance, which would allow no motion in the veſſels within the cranium, and would require us to invent ſome ſpecious means to account for the circulation of the blood in the brain, different from that of the other viſcera of the body. Were the brain thus incompreſſible, or rather ſolid, ſo as to prevent a free action of the veſſels within the cranium, then, as the blood enters with an evident pulſation, it muſt neceſſarily have returned by the veins with a diſtinct pulſation; but this pulſation is loſt here, as in the other veſſels of the body, before it returns by the ſinuſes. When the blood is ſent into the arteries of the brain, by the ſtroke of the heart, they dilate; and this dilatation the pliability of the brain allows, by throwing a comparative degree of preſſure upon the veins. Again, when the arteries (during the dilatation of the heart) are in action, and contract, their blood enters the veins, ſo as to give to them a degree of dilatation equivalent to their former compreſſion, and which now gives the freedom of contraction in return to the arteries; without any compreſſion, therefore, of the brain into a leſſer ſpace, there is an activity allowed in the veſſels.

This degree of motion, communicated through the brain, is very ſmall, nor does it affect the function of the brain; as we ſee, when the ſcull is laid open, and the pulſations of the arteries are, as it were, accumulated, in their effect, to one point; for here the patient does not ſuffer, although the brain beats ſo as to be ſenſible to the eye. The accumulation of the blood in

the brain may be obſtructed, or it may be accelerated, until this velocity affects the function *: or the blood may be accumulated ; but during this accumulation of the blood there muſt be a proportional ſpace, freed by the abſorption of the brain itſelf, or the partial accumulation of one part of the vaſcular ſyſtem of the brain muſt neceſſarily be accompanied by a deficiency of the other.

* There is much ſound reaſoning and ingenuity waſted on the ſubject of the circulation of the brain : As the gentle murmuring of a ſtream, ſays Lower, lulls to repoſe, while the mind is diſturbed, or the imagination awakened by the din of a cataract ; ſo ſleep is induced by the gentle flow of the blood in the brain, or flies when the circulation is accelerated. As the fatigue and reſt of the body required a variation in the impetus of the blood towards it, the neceſſary conſequence was a variation in the degree of velocity in the circulation and quantity of blood in the head, and this to Lower is the reaſon of the viciſſitude of wakefulneſs and ſleep. The ſimple fact of the effect of preſſure upon the ſurface of the brain inducing an oppreſſion of the ſenſes has occaſioned all their theories of ſleep to turn upon this one idea of preſſure on the brain.

CHAP. III.

OF THE VENTRICLES AND INTERNAL PARTS OF THE BRAIN.

OF THE CAVITIES OF THE BRAIN IN GENERAL.

THERE are within the Brain many tubercles and irregular ſurfaces, of which it is infinitely more difficult to convey an idea by deſcription than of the external parts. Theſe ſurfaces, as the name implies, lie in contact without adhering; and form what we call, though not perhaps with ſtrict propriety, the cavities of the brain. Not being ſeparated, they are ſcarcely to be conſidered as cavities, although they be capable of diſtention by the infiltration of the fluid into them. The ſurface of the cavities or ventricles of the brain is naturally bedewed with a fluid or halitus, which flows from the general ſurface of the ventricle, and from the plexus choroides. This moiſture preſerves thoſe ſurfaces from adheſion; during life and health it is not accumulated ſo as to form a fluid; but in many diſeaſes, and after death, it is effuſed or collected into a fluid. The external convolutions of the brain we have ſeen to be cineritious on the ſurfaces: the internal ſurface of the brain may be conſidered alſo

alſo as forming convolutions; but they are chiefly medullary, and are more irregular, or rather have a greater variety of ſhape, than thoſe of the outer ſurface.

In regard to the uſe of the ventricles of the brain, ſince the hypotheſes of the older phyſicians have been tacitly rejected, no opinion has been offered, except this, that "they ſeem to be made of a neceſſary conſequence, and towards the greater uſe and diſtinction of parts;" or, as we have already had occaſion to mention, that the ventricles ſerve to increaſe the ſurface of the pia mater, and that whatever may be the purpoſes which are ſerved by that membrane on the ſurface of the brain, we muſt ſuppoſe the ſame to be performed by it within the ventricles. But this is a concluſion which may not be altogether ſatisfactory to an inquiſitive mind.

It is neceſſary to take into conſideration the general peculiarities of the brain: we find that within the ſcull there is no adipoſe ſubſtance, though it pervades every other part of the body. We at once ſee a reaſon for this. It is evident that as the fat is ſo inceſſantly undergoing changes (being alternately abſorbed and depoſited); as at one time it is depoſited in greater quantities and at another abſorbed; as it is in perpetual variation according to the prevailing habits of the body, the proportion of exerciſe taken, or the ſtate of the health; its continual changes would have the very worſt conſequence upon ſuch a part as the brain; that if accumulated it would oppreſs the circulating veſſels; if rapidly abſorbed it would be followed by accumulation or ſurcharge of the veſſels; for the ſcull does not allow

of diſtention, nor is it poſſible that it can admit of depletion.

I conceive the ventricles to be a proviſion for allowing thoſe changes to take place, which neceſſarily, from time to time, ariſe, or are occaſioned by diſeaſe in the ſubſtance of the brain itſelf: they prevent an inſtantaneous bad effect. When fluids diſtend the ventricles, it ſometimes occurs to us that the fluid, ſecreted and accumulated, muſt have compreſſed the ſubſtance of the brain, and cauſed its abſorption; but I conceive that frequently the cauſe is reverſed; the abſorption of the maſs of the brain being the diſeaſe or its conſequence, and the fluid being poured out in the ventricles to ſupply this deficiency: I alſo conceive that the collected fluid being in the central parts, is a particular proviſion by which the whole maſs of the brain is kept uniformly diſtended; whereas, if the ſurface had been equally, or more diſpoſed to ſuch ſecretion of fluid, the internal parts would have fallen flaccid, and been compreſſed rather than ſupported.

There cannot be a more erroneous notion than that in Hydrocephalus the compreſſion produced by the ſecreted fluid occaſions the waſting of the brain. In that diſeaſe the ſubſtance of the brain is not firm and compreſſed, ſo as to prevent the veins from being completely filled; but, even in a very early ſtage, the maſs of the brain is ſoft and fluid; the veins peculiarly diſtended or enlarged; and from the firſt or inflammatory ſtage of the acute hydrocephalus, or the permanent ſtate of the chronic, the diſeaſe is not a dropſy of the ventricles, but a univerſal affection of the brain.

The

The effect of the disease is, that there is a change in the relative powers which incessantly secrete and absorb the brain itself, as every other part of the body is secreted and absorbed. And in consequence of this there is a diminution of the solids of the brain, and an accumulation of the fluids to supply their loss.

It is not to be supposed that the ancients, so fertile in their hypotheses, and so easy in their proofs, could neglect the evident importance of the ventricles of the brain. We accordingly find that the spirits were manufactured in these cavities; that they were the "spirituum animalium officina," whence the spirits were conveyed over all the nervous system *. They were again degraded from this higher office, and became the mere receptacles of the excrementitious matter of the brain (meras cloacas esse asseruerint †); and Willis seems inclined still further to degrade the importance of the ventricles, by considering them merely as of secondary importance; or rather as resulting solely from the accidental conformation of the brain ‡. Again we find it a prevalent opinion that the ventricles

* Lately, by chemical aids, (which makes the cineritious substance black, or dark brown, while the medullary matter remains white, or takes a slight greenish tinge,) the origins of many of the nerves have been traced into the substance of the brain, even tothe surface of the ventricles, which has given occasion to the revival of similar ideas of the use of the ventricles.

† Willis Cereb. Anat. p. 32.

‡ "Porro si quis cerebelli fabricam exacto considerat, et serio perpendit, quod hi ventriculi non ex primaria naturæ intentione efformentur, at secundario tantum et accidentaliter de cerebri complicatione resultent," &c.

cles contained air; that the air ſupported the ſoft medullary ſubſtance of the brain; and that it gave motion to the whole maſs, ſo as to circulate the ſpirits in the ſubſtance of the brain *.

OF THE CORPUS CALLOSUM AND CENTRUM OVALE OF VIEUSSENS.

THE CORPUS CALLOSUM is a medullary body which is a centre of communication; or it is the great commiſſure † paſſing betwixt the hemiſpheres of the cerebrum ‡: it is ſeen without inciſion by merely ſeparating thoſe hemiſpheres with the fingers. It is a white body, firmer than the reſt of the medullary ſubſtance. It is but ſlightly convex upon its upper part, but turns convex downwards upon the fore and back

* Malpighi.

† Commiſſure is a term applied to thoſe tracts generally of medullary matter, which paſſing through the brain are ſuppoſed to be a medium of communication.

‡ Willis conceiving the ſpirits to lodge and circulate in the ſuperficial convolutions of the brain, (upon the conformation of which depended the capacity or ability,) gives to the corpus calloſum the property of collecting and concentrating the ſpirits, " quaſi in " *publico emporio* commorantur;" and here they were depurated by repeated circulation.—But the language in which all this is delivered better veils the abſurdities of the doctrine: " ſpiritus recens nati " undequaque ab extima hujus corporis ora verſus anteriorem iſtius " corporis calloſi partem, ubi craſſimum exiſtit, perpetim blande " ſcatent; ibidemque, ſi opus fuerit, aut imaginationis actui impen- " duntur, aut medullæ oblongatæ crura ſubeuntes, appendicem ner- " voſam actuant et inſpirant." What remains ſuperfluous of the ſpirits returns backwards and circulates through the fornix, and is ſtill farther ſubtilized, " hoc motu ſubtiliores quoſdam phantaſiæ actus " peragunt."

part.

part. As the corpus callofum is the continuation of the internal medullary fubftance of the brain, it is fuperfluous to fay that it is continued down, anteriorly, into the medullary matter betwixt the corpora ftriata, terminating in its pedunculi; or, backwards, that it is continued with the fornix and cornua ammonis and the furface of the pofterior prolongation of the lateral ventricle.

We fee upon the furface of the corpus callofum two medullary lines confiderably raifed, running parallel to each other* in the length of the body. Betwixt thefe falient lines there is of courfe a kind of rut, called fometimes the rapha, or future, which may be confidered as dividing this body into two equal parts, and which, in truth, forms the accurate divifion of the two fides of the whole brain†.

Other lines, lefs elevated from the furface, are to be obferved running acrofs thefe, as if paffing from one hemifphere to the other. If the corpus callofum be cut horizontally, and the fection be continued into the fubftance of the hemifpheres, we ftill can perceive thofe tranfverfe lines, and obferve them to be loft in the medullary matter of the hemifpheres‡.

THE

* They are not ftrictly parallel in all their length; we find them often feparated both upon the fore and back part; but generally more feparated upon the back part, and even fometimes they are curved.

† In which conceit Duverney calls this "clef du cerveau," from its being the centre of communication. Tom. i. p. 39.

‡ The neceffity of explaining paralyfis and convulfive motions of that fide of the body oppofite to the fide of the brain injured, have made

THE CENTRUM OVALE is merely the appearance which the white and internal part of the cerebrum takes when the brain is cut horizontally on the level of the corpus callosum; for then the corpus callosum is the centre of the great medullary mass of the cerebrum, and the external cineritious matter being on the edges only forms it into an irregular oval.

THE SEPTUM LUCIDUM.

THE two lateral ventricles lying under the corpus callosum and medullary centre are divided by a partition, which descends from the lower surface of the corpus callosum, and rests upon the fornix. This septum of the ventricles is transparent, and consists of two lamina, and these consist of medullary and cineritious matter *. Betwixt these is the cavity of the septum lucidum †. The size and shape of this cavity differs in a variety of subjects. It is of a triangular shape, and from eighteen to twenty lines in length ‡. It has a fluid exhaling into it like the ventricles, and is by some counted as a fifth ventricle: according to Santorini it opens in the base of the brain, opposite to the union of the optic nerves. Vieussens describes it communicating with the third

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made anatomists attend to those transverse lines, in the hopes of finding such a decussation of these lines as would account for it. Sabbatier says, they have brought themselves to believe that there was a decussation, but after careful investigation he could find no such thing. See Winslow. Ludwig (de Cinerea Cerebri, sub. p. 5.) observed striæ of cineritious substance in the corpus callosum. See also Gunz. and Haller.

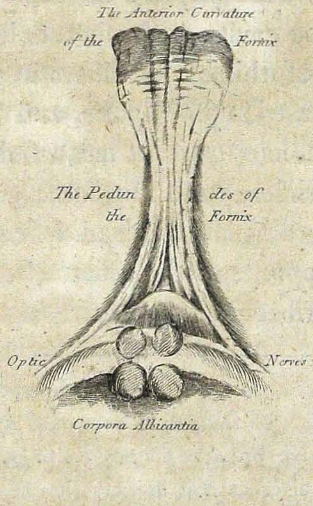
* Vicq. d'Azyr.

† It was discovered by Silvius. See also Santorini.

‡ Sabbatier.

ventricle.

ventricle *. Winſlow alſo has ſeen it reaching a great way backwards, and conceives it to open into the third ventricle. Soemmerring deſcribes it as large in the middle, contracted backwards, and having no communication; but he aſſerts that it is ſhut in on every ſide †. In the baſe of the brain we find a narrow longitudinal ſulcus betwixt the pedunculi of the corpus calloſum. In the bottom of this cavity there is a medullary lamina, which Vicq. d'Azyr calls "*Cloiſon à la cavite du ſeptum lucidum.*" And the ſulcus he calls "*Foſſe de la baſe du* SEPTUM LUCIDUM." By a careful ſection of this medullary ſubſtance we lay open the cavity of the ſeptum lucidum.



* "In qua pellucidam non raro reperimus aquamque haud dubie "in tertium illabitum ventriculum." Vieuſſens de Cerebro, p. 59.

† De Corporis Humani Fabrica, tom. iv. p. 55.

LATERAL

LATERAL VENTRICLES.

UNDER the corpus callofum and medullary centre, are the lateral ventricles. They are diftinguifhed into right and left. They are of a very irregular fhape, ftretching into three prolongations or cornua, whence they have the name of tricornes. They are the great ventricles of the brain; the third and fourth being comparatively very fmall. What may be confidered as the bodies of thefe ventricles are formed betwixt the corpus callofum and medulla of the brain, and the convexity of the corpora ftriata and thalami nervorum opticorum. Following the cavity forwards, we find what is called its ANTERIOR HORN or finus, formed betwixt the more acute convexity of the corpus ftriatum and the anterior part of the corpus callofum; into the pofterior lobe of the cerebrum, refting upon the tentorium, there ftretches backwards with fome confiderable curve, and, at the fame time, with a flight inclination downwards, the POSTERIOR HORN.

Again, the INFERIOR or DESCENDING HORN is like the continued cavity of the ventricle; it takes a curve backwards and outwards, and then turning forwards it defcends into the middle lobe of the brain.

The lateral ventricles do not terminate in the others by any of thofe prolongations; but they communicate, upon a very high level, with the third ventricle and with each other, by a wide opening, formed under the fore part of the arch of the fornix. This communication we eafily find by following the choroid plexus forward and under the fornix: it is a fpace betwixt the moft anterior part of the convexity of the optic thalami and the anterior crura of the fornix.

OF THE PARTS SEEN IN THE LATERAL VENTRICLES.

THE FORNIX is a medullary body, flat, and of a triangular ſhape, which divides the two lateral and the third ventricles: its lower ſurface is towards the third ventricle: its lateral margins are in the lateral ventricle. On its upper ſurface it ſupports the ſeptum lucidum, or partition of the two lateral ventricles, and under its moſt anterior part is the communication betwixt the lateral ventricles and the third ventricle*. One of the angles is forward, and the other two towards the back part: it reſts chiefly upon the thalami nervorum opticorum, but it is ſeparated from them by a vaſcular membrane, which is continued from the external pia mater, and which ſtretches into the brain betwixt the poſterior part of the corpus calloſum and tubercula quadrigemina, and which membrane connects the plexus of the lateral ventricle. The fornix leaves betwixt it and the concave face of the moſt anterior part of the corpora ſtriata, a triangular ſpace, which is in part occupied by the ſeptum lucidum.

The extremities of this body are called crura. The poſterior crura coaleſcing with the corpus calloſum, (which is continued downwards poſteriorly,) are prolonged into the hippocampi, and the anterior crura forming the anterior angle being cloſe together, bend downwards behind the anterior commiſſure, and are connected with it: they then bend round the thalami, and may be traced into the crura cerebri; or, accord-

* Of this communication ſee farther in the Anatomy of the Brain illuſtrated by Engravings.

ing

ing to others, they form the corpora albicantia*. Thoſe pillars or crura of the fornix are fibrous in ſome ſlight degree like a nerve. This is to be obſerved by cutting them either acroſs or in their length †.

Upon the lower ſurface of the fornix there are lines like thoſe of the corpus calloſum, and which are erroneouſly conceived by many to be the impreſſion of the veſſels of the velum. It is this lower ſurface of the fornix which is called LYRA, CORPUS PSALLOIDES, it being compared to a ſtringed inſtrument ‡.

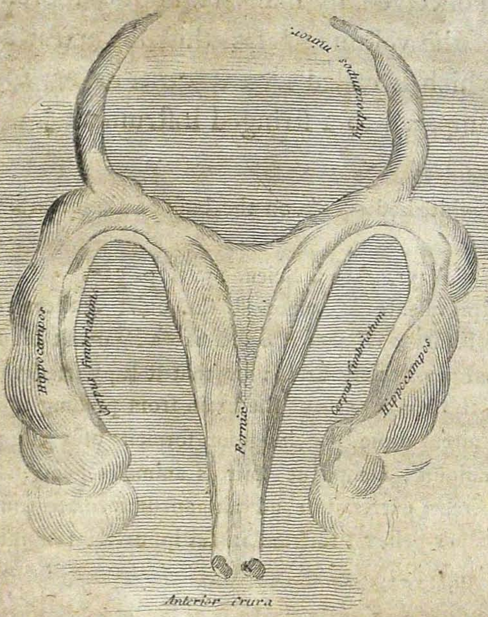
* Two white bodies ſeen on the baſe of the brain behind the infundibulum.

† Vicq d'Azyr, Acad. Scien. 1781, p. 517.

‡ The prevalent idea amongſt the older authors regarding the uſe of the fornix was, that it acted like a ligament binding together the internal parts of the brain; or that it ſupported the incumbent weight of the upper parts of the brain from preſſing upon the lower. "Verum alter atque iſte inſignior fornicis uſus eſſe videtur quem "modo inuimus; nempe ut ſpiritus animales per ejus ductum ab "altera cerebri extremitate ad alteram immediate tranſeant; atque "ita quaſi per pelicani roſtrum in ſui ipſius ventrem intortum circu-"lentur." Willis.

OF THE HIPPOCAMPI, OR CORNUA AMMONIS, AND OF THE TENIA HIPPOCAMPI.

Plan of the Connections of the Fornix with the Hippocamp.s &c.



THOSE parts are to be ſeen continued from the poſterior crura of the fornix. We have obſerved, that upon the back part, the fornix adheres to, or is continuous with, the corpus calloſum. We ſhall find alſo that its poſterior crus on each ſide divides into two lamina of medullary matter: the one of theſe is continued into the cornu ammonis, and the other (being the anterior of theſe portions) forms the tenia hippocampi.

The

The hippocampos is narrow at its commencement in the poſterior crus of the fornix *; but it is enlarged as it deſcends, following the courſe of the inferior prolongation of the lateral ventricle towards the baſe of the brain. It is, indeed, merely a relief or particular convexity of the floor of this lower horn of the ventricle, like a pad. The inferior extremities of the hippocampi on each ſide turn inwards, pointing to the crura cerebri, and taking thus a curve like a ram's horn †. In its whole extent the hippocampos conſiſts of an internal cineritious ſubſtance, and a ſuperficial layer of white medullary matter ‡.

The TENIA HIPPOCAMPI, OF CORPUS FIMBRIATUM, is the prolonged margin of the fornix: it is merely the thin edge of the hippocampos, which follows in the whole of its circuit, and terminates in an acute point near its bulbous extremity.

* In ſpeaking of the origin of the hippocampos as from the fornix, I mean ſimply that the ſtudent having gained the knowledge of one part of the brain may trace the others from their relation to it, and that, underſtanding the ſituation and relation of the fornix, he traces its crura until he finds them terminating in the hippocampos. We might fully as well ſay that the hippocampi are formed from the poſterior part of the corpus calloſum, for they are the ſame medullary matter continued.

† Betwixt the extreme point of the hippocampi and the crura cerebri (when the baſe of the brain is turned up) we can inſinuate the probe into the inferior horn of the lateral ventricle without piercing the ſubſtance of the brain, but merely tearing the pia mater.

‡ "Vers la partie inferieure et poſterieure du corps calleux, on "trouve, de chaque côté, un petit bourrelet de ſubſtance griſe qui ſe "prolonge dans l'epaiſſeur de l'hypocampe dont il fait partie: ce bour-"relet eſt recuvert dans ſon principe par une lame de ſubſtance "blanche." Vicq d'Azyr, loc. cit.

 the

The LESSER HIPPOCAMPOS, or COLLICULUS, is a relief or convexity in the floor of the poſterior horn of the ventricles, which may be traced backwards from the crura of the fornix. It has the ſame relation to the fornix which the greater hippocampos has, and lies in the poſterior horn or prolongation of the ventricle into the poſterior lobe of the brain, in the ſame way in which the great hippocampos lies in the inferior horn or prolongation of the ventricle into the middle lobe of the brain.

The velum and plexus require to be taken away before we can fully underſtand the ſituation of the third ventricle, or of thoſe tubercles which are but partially ſeen in the lateral ventricles.

The VELUM lies in the centre of the brain, and extends from the ſurface of the brain inwards betwixt the poſterior lobes of the cerebrum and the cerebellum, then betwixt the corpus calloſum and nates and teſtes, and then under the fornix. It forms thus a great communication betwixt the external and internal membranes of the brain. As it lies under the fornix, that medullary lamina adheres to it, while the velum again adheres to the thalami nervorum opticorum. Its margin ſeems to be terminated laterally by the choroid plexus (when we view it after raiſing the fornix); but it is not ſtrictly ſo, for the choroid plexus is continued with the membrane of the ventricles, and has no where a termination. For the vaſcularity of this membrane, turn to what has already been ſaid in ſpeaking of the internal veins of the brain.

Seeing how the plexus choroides are formed and connected, they cannot be ſtrictly ſaid to have either beginning

ning or termination; they are the connected folds and plicæ of the internal membrane of the ventricles loaded with veſſels; but to deſcribe them intelligibly we muſt, notwithſtanding, trace them in this manner. The PLEXUS of the LATERAL VENTRICLES riſe from the bottom of the inferior horns of theſe ventricles betwixt the pedunculi or crura cerebri and the termination of the hippocampi; they lie large and fleſhy-like in that lower horn. As they riſe into the ſuperior level, they are at their greateſt ſize (there they have often a diſeaſed appearance, being hard, and as if ſchirrous or full of little veſicles or hydatids); they then paſs forwards and inwards, diminiſhing in thickneſs until they coaleſce under the fornix, and immediately behind the communication betwixt the ventricles. The PLEXUS OF THE THIRD ventricle, formed by the union of thoſe of the lateral ventricles, turns back upon the lower ſurface of the velum, and is comparatively very ſmall.

The CORPORA STRIATA are ſmooth, cineritious convexities in the fore part of the lateral ventricle. They are ſomewhat of the ſhape of a pear; they are obtuſe forwards; they approach each other towards the fore part with a regular convexity, and they are narrow as they paſs backwards, ſeparating at the ſame time; their poſterior extremity being as it were puſhed out by the thalami nervorum opticorum. Theſe laſt lie more under the back part of the fornix, and are more concealed when the lateral ventricle only is laid open. Theſe bodies are called ſtriata, from the intermixture of the medullary matter, which gives the appearance of ſtriæ when they are cut. They deſcend down to the baſe, and give origin to the firſt pair, or

 olfactory

olfactory nerves *. The ſtriæ of medullary matter paſs from above downwards, they therefore appear in the horizontal ſections of this body like white points. A ſuperficial horizontal ſection of the corpora ſtriata ſhows thoſe ſtriæ connected with the medullary matter of the middle and poſterior lobe. A deeper inciſion brings into view a maſs of cineritious ſubſtance betwixt thoſe ſtriæ and the medullary matter of the middle lobe. Another inciſion ſhows the courſe of the ſtriæ altered, and brings into view the connection betwixt the corpora ſtriata of each ſide, by means of the anterior commiſſure †.

The COMMISSURA ANTERIOR is a cylindrical medullary cord, which unites the fore and lower part of the corpora ſtriata, and which ſpreads its connections for a full inch and a half into the middle lobe of the brain upon each ſide. We ſee it ſtretched tranſverſely immediately under the anterior crura of the fornix. It is in figure like a bow; its extremities ſtretching (with a convexity forward) into the middle portion of the brain towards the extremity of the foſſa ſilvii, where it terminates in the medullary matter of the middle lobe of the brain.

The THALAMI NERVORUM OPTICORUM are hid by the poſterior angles of the fornix, and the plexus choroides

* Sommerring.

† "*Hæc pars commune ſenſorium eſt*, quod ſenſibilium omnium "ictus a nervis cujuſque organi dilatos accipit adeoque *omnis ſenſionis* "*perceptionem afficit*; cujuſmodi ſenſibilium ictus, cum hinc ulterius "in cerebrum trajiciuntur, *ſenſioni* ſtatim imaginatio ſuccedit; atque "inſuper hæc corpora, uti ſenſuum omnium impetus, ita motuum "localium ſpontaneorum primos inſtinctus ſuſcipiunt." Willis, Edit. 4. p. 43.

des: we do not ſee them fully until we have lifted the fornix and the velum or membrane which ſtretches under the fornix. They are ſomewhat of an irregular oval ſhape; they are whiter than the corpora ſtriata, their ſurface being chiefly of medullary matter. Internally they are cineritious; and the medullary and cineritious matter is blended in ſtriæ like the anterior tubercles of the ventricles on the corpora ſtriata.

The thalami nervorum opticorum, having their convex ſurface towards each other, unite under the fornix by what is called the COMMISSURA MOLLIS, in oppoſition to the commiſſura magna, which is the corpus calloſum; the commiſſura anterior, which unites the fore part of the corpora ſtriata; and the commiſſura poſterior, which is yet to be deſcribed.

Thus the ſoft commiſſure of the brain, or the union of the optic thalami, is ſo ſoft that the ſlighteſt force will tear it, or in diſſection, the parts being unequally ſupported, the thalami will be ſeparated and this connection loſt *. After ſuch ſeparation of the tubercles there remains very little appearance of their having been united. Sabbattier, after the moſt careful diſſection, ſays expreſsly that he could never obſerve this union, and he conceives, that in the ſmoothneſs of the contiguous ſurfaces he has a proof of there never being ſuch a union; but he goes on to ſay, "The fruits of my "reſearch were, that I conſtantly found a ſoft cord of a "cineritious colour, and about a line or a line and a "half in diameter paſſing betwixt them."

* Morgagni and Vicq d'Azyr ſay they have ſeen this commiſſure double: it may, however, have been a partial laceration of it.

I have

I have ſeen, when the ventricles were diſtended in hydrocephalus, and the communication betwixt the three ventricles enlarged to a ſquare cavity of nearly an inch in diameter*, that this union was drawn out to ſome length, but ſtill was above half an inch in diameter. The commiſſura mollis is exceedingly ſoft, of a cineritious colour, and veſſels are ſometimes ſeen to croſs upon its ſurface. It ſeems to be the continuation of the grey or cineritious ſubſtance which covers the internal ſurface of the optic thalami †.

Towards the fore part of the thalami we have to obſerve a peculiar eminence or convexity, viz. the ANTERIOR TUBERCLES of the optic thalami. In making a horizontal ſection of the thalami, we find that we cut acroſs a medullary ſtreak or cord which deſcends from this tubercle to the mamillary proceſſes, or corpora albicantia, in the baſe of the brain ‡. Its courſe is deep in the ſubſtance of the brain, and ſomewhat oblique. The limits of the thalami externally are contiguous to the corpus ſtriatum, but betwixt them there intervenes a white medullary tract, which is continuous with the medullary ſtriæ, and which, as it marks the limits of the two great tubercles of the lateral ventricles, takes a courſe inwards towards the anterior pillars or crura of the fornix and middle of the anterior commiſſure. The ſurface of this tract, as ſeen in the

* In quadrupeds the adheſion is more extenſive.

† Mais il n'y a point de continuité, proprement dite, entre la ſubſtance intime de ces couches et la commiſſure molle dont il s'agit. Vicq d'Azyr, Planc. de Cerv, p. 23.

‡ See Vicq d'Azyr, plate xii. Mem. de l' Acad. Royale, 1781, p. 528, and plate 2, fig. 5.

lateral ventricle, is the TENIA SEMICIRCULARIS GEMINUM, which we ſhall preſently more particularly deſcribe.

To underſtand the further connections and importance of the optic thalami we muſt diſſect the baſe of the brain. There we find that it is through the corpora ſtriata, and the thalami nervorum opticorum, that the crura cerebri eſtabliſh their extenſive connection with the internal maſs of the brain; particularly we find that the crura ſhoot up into the back and lower part of the thalami.

Here on the lower part alſo we may obſerve the TRACTUS OPTICUS, which we may trace backwards from the optic nerves. They ſurround the crura cerebri with a ſemicircular ſweep, ſwelling out at the ſame time, and terminating in three conſiderable tuberoſities: they are finally confounded with the lower part of the optic thalami *; at the ſame time there runs up a diviſion of it into the nates.

The TENIA SEMICIRCULARIS GEMINUM is the tract of the medullary matter, which is betwixt the two great anterior tubercles of the lateral ventricle, the corpus ſtriatum and thalamus nervi optici. Towards the fore part of this tract its ſurface is covered with a layer of a ſemitranſparent greyiſh matter, through which we ſee the

* Willis ſeeing the firſt and ſecond pair of nerves ſo cloſely connected with theſe tubercles, and ſuppoſing, as we have mentioned in a former note, that the corpora ſtriata were the common ſenſorium, concludes, " hinc ratio patet, cur odores ſine olfactus objecta " ipſum adeo cerebrum feriunt, et immediate afficiunt; item cur " inter viſionem et imaginationem communicatio citiſſima habe" tur." P. 44.

veins

veins which paſs from the ſurface of the corpora ſtriata to join the vena galeni *. Sabbattier makes the anterior extremity of this medullary body join the anterior pillar of the fornix : Haller makes it join the anterior commiſſure : and Vicq d'Azyr ſays they ſeparate again, where they ſeem to unite forwards and loſe themſelves on the corpora ſtriata. Their poſterior extremities are loſt in the hippocampi ; they thus form a kind of longitudinal commiſſure which eſtabliſhes a communication betwixt the fore and back part of the cerebrum.

OF THE THIRD VENTRICLE.

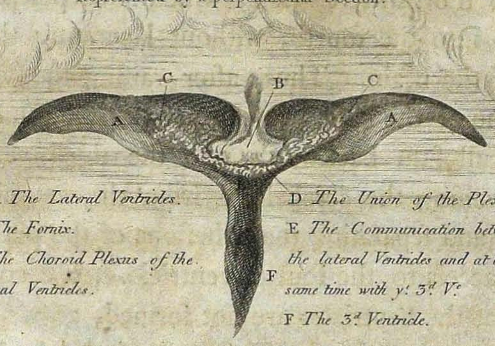
THE third ventricle does not at all anſwer to the conception we form of the ventricles from the lateral ones. It is a mere ſulcus, lying betwixt the thalami nervorum opticorum, and betwixt the crura cerebri, which are continued down from theſe tubercles. It is a longitudinal ſlit, rima, or gutter-like cavity, which is made irregular, and is divided by the union of the optic thalami ; and finally, it is canopied by the fornix and vaſcular velum which ſtretches over the thalami †.

* "Quelquefois il ſe detache du tænia ſemicircularis entre le "corps ſtrie et la couche optique un filet blanc, que faiſſant un angle "très aigu, ſoit en devant, ſoit en arrière, monte à une certaine hau-"teur ſur le corps cannele." Vicq d'Azyr, Mem. de l' Acad. Royale, 1781, p. 530.

† "Hanc caveam ventriculum tertium vulgo vocant, quæ et ipſa "cum plena ſint omnia nihil eſt niſi contiguorum thalamorum limes." Haller.

The

Plan of the communication
of the Lateral & 3ᵈ Ventricles
Represented by a perpendicular Section.



A A *The Lateral Ventricles.*
B *The Fornix.*
C *The Choroid Plexus of the lateral Ventricles.*
D *The Union of the Plexus.*
E *The Communication betwixt the lateral Ventricles and at the same time with yᵉ 3ᵈ Vᵉ*
F *The 3ᵈ Ventricle.*

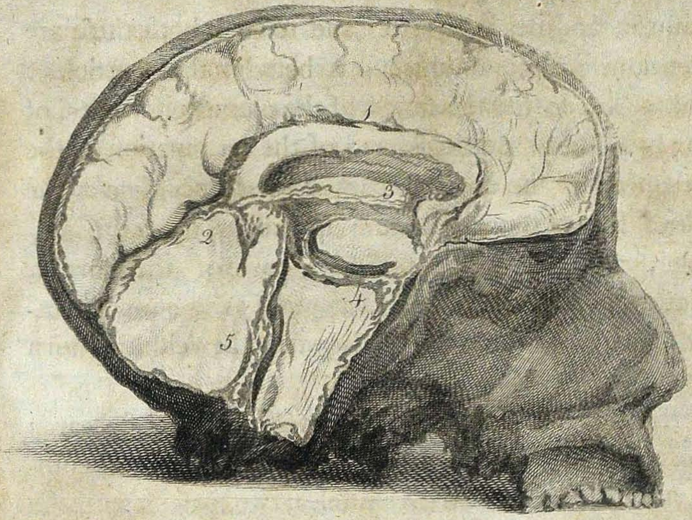
The third ventricle opens forward and upwards into the two lateral ventricles, and under the common communication it opens into the infundibulum. Backwards it is continued by a canal which paſſes under the tubercula quadrigemina, or nates and teſtes, into the fourth ventricle. The bottom of the third ventricle is cloſed by a ſmall ſtratum of cineritious matter, *cloiſon pulpeuſe du troiſieme ventricule*; this fills up the ſpace betwixt the junction of the optic nerves and the anterior commiſſure. We ſee it when diſſecting the baſe of the brain. Lifting the optic nerves, we ſhall find it ſtrengthened by the pia mater, and conſiſting of ſtriæ which paſs obliquely backwards and downwards, and ſome of which, while they adhere to the optic nerves, paſs into them.

As we have found that the pia mater could be traced into the lateral ventricles, and as by tearing

6 with

with the probe the connections of those membranes we could penetrate into the lateral ventricle without piercing the substance of the brain; so here we can penetrate into the third ventricle, which is deepest of all; and also into the fourth, without lacerating the substance of the brain. Thus, after raising the vascular membrane of the base, we can pass a probe under the corpus callosum backwards into the third ventricle, and by raising the cerebellum from the medulla oblongata, and separating the adhesions of the pia mater, we get access to the fourth ventricle. We conclude then, that the ventricles are not formed, as we should at first conceive, in the substance of the brain, but that they are formed by the replication and foldings of the convolutions of the brain.

Plan of the Inflections of the Pia Mater



See foot Note.

OF THE INFUNDIBULUM.

As I have explained in my tables of the brain, there is much confuſion regarding the terms vulva and anus. Vulva is the ſpace by which the three ventricles communicate, as ſeen when the fornix is lifted, viz. be-

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EXPLANATION OF THE PLATE.

1. The pia mater deſcending betwixt the hemiſpheres to the corpus calloſum.
2. Betwixt the poſterior lobe of the cerebrum and the cerebellum.
3. Under the fornix in form of the velum.
4. Into the inferior horn of the lateral ventricle.
5. Into the bottom of the fourth ventricle.

twixt

twixt the thalami nervorum opticorum and before the commiſſura mollis. The anus is behind this commiſſure, and near the nates and teſtes; both theſe are mentioned as communications betwixt the ventricles: but we know that the union of the plexus choroides, of the two lateral ventricles, and of the termination of the velum under the anterior part of the fornix, leaves the vulva free. But the velum ſpreading over the thalami, and under the poſterior part of the fornix, cloſes up the anus; and it appears as a communication ſimilar to the other only when the velum is torn up.

If we paſs a probe gently downwards and forwards from the vulva or foramen commune anterius, or communication betwixt the ventricles, we paſs it into the infundibulum. The INFUNDIBULUM is a funnel of a ſoft cineritious matter, which leads from the bottom and fore part of the third ventricle towards the glandula pituitaria, which is ſeated in the ſella turcica of the ſphenoid bone.

The infundibulum is formed of cineritious matter, which is continued from the bottom of the third ventricle, and which adheres to the back part of the optic nerves; or, according to Warthon, of an external membrane with cineritious matter internally. Its cavity becomes contracted before it reaches the glandula petuitaria. Whether it be really capable of conveying the fluids of the ventricles, or whether it be actually pervious, is likely to remain a diſputed point. Tarin, and M. Adolphus Murray, and Haller, believe with the older writers that it is pervious. Sommerring and Vicq.

Vicq d'Azyr have in their experiments found it ſhut *. But to the opinion that the infundibulum conveyed the ſuperfluous moiſture from the ventricles †, it did not ſeem neceſſary to Vieuſſens that we ſhould find it to have a cavity in all its length. He conceived that where the apparent cavity terminated, leſs viſible pores were continued towards the gland.

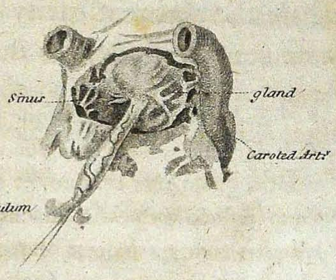
* "Sed non ad apicem uſque pervium." Soemmering.

† "Structura, ſituque infundibuli ſpectatis, connexionis, & ſo- "cietatis, quam cum cerebro, et glandula pituitaria habet, rationibus "æquo judicio perpenſis, unicum illius uſum eſſe, ut aquoſum, ſeu "lymphaticum quemdaèm cerebro depluentem humorem, majoris, "ad inſtar vaſis lymphatici excipiat et pituitariam verſus glandulam "ſenſim tranſmittat, non autumare non poſſumus: Etenim eum inter- "textarum plexibus choroïæis glandularum uſus ſit, ut ſanguinis "calvariam ſubeuntis, ſpirituſque animalis materiam ſuppeditantis, "aquoſiorem partem, deſinentibus in ipſas ab arteriis depoſitum ex- "cipiant, quæ deinceps per inſenſiles rariſſimæ, qua obducuntur, "membranæ poros, ſenſim transfluit, et partim per vulvam partimve "per anum, in tertium cerebri ventriculum delabitur; nullus eſſe "videtur ambigendi locus, quin aquoſus omnis humore glandulis, "quæ plexuum choroïdæorum vaſis interſeruntur, ſenſim affluens, ad "infundibulum deferatur." Vieuſſens, p. 50. Such was the opinion regarding the œconomy of the brain, and now we have no theory, good or bad, nor any explanation of this connection of the gland with the ventricles of the brain to offer.

INFUNDIBULUM AND PITUITARY GLAND.

Gland and Infundibulum taken out.

Pituitary Gland Seated in the Sella Turcica.



D. Lizars, sculp.

What is called the PITUITARY GLAND is a rediſh body of a glandular-like ſtructure *, which is ſeated in the ſella turcica of the ſphenoid bone. It is plain upon its upper ſurface, or rather perhaps a little hollowed, of a globular ſhape below, and having a diviſion into two lobes. The infundibulum terminates in it, piercing the dura mater, a thin lamina of which ſpreads over the gland. The gland, as is ſeen in the above plate, lies ſurrounded with the circular ſinus, and has the cavernous ſinus upon the ſides ; into theſe laſt, veſſels have been ſeen to paſs from the gland †, which, as Soemmerring obſerves, were probably veins. A diſtinction of ſubſtance has been obſerved in this

* It perhaps has only the form of a gland. Haller ſays " non " acinoſa quidam, neque nullius alterius glandulæ ſimiles, quæ po- " tius cerebri quedam ſit appendix." See alſo Bordeu, recherch. Anatomiq. ſur les Glands.

† Adolph. Murray de infundib.

gland, and it is by ſome conſidered as a part of the brain, or being like the cineritious ſubſtance, it has been ſuppoſed that it gave nerves to the fifth or ſixth pair.

It was conceived that the body receiving the ſuperfluous moiſture of the brain, conveyed it into the noſe; or into the neighbouring ſinuſes *. To countenance this opinion, there was no want of caſes proving the accumulation of the fluids of the ventricles, in conſequence of the ſchirrus of this gland †, while in truth diſſection has ſhown no connection betwixt the diſeaſes of the ventricles and pituitary gland. M. Littre gave both a vaſcular ſtructure and muſcular fibres to this body, and conceived that its operations brought down the water and air from the ventricles of the brain ‡.

THE TUBERCULA QUADRIGEMINA.

The tubercula quadrigemina, or nates and teſtes, are ſeen when we continue to lift back the poſterior part of the fornix and corpus calloſum, and when we have lifted back the velum with the vena galeni. We find, in doing this, that the velum is connected with the pineal gland, which is ſeated upon theſe tubercles.

* Lower Tract. de Corde.

† Schneider (de catarch.) firſt oppoſed this theory; ſhowed that there was no communication betwixt the brain and the noſe, and maintained that no fluid, not even the blood which flowed from the noſe, had any connection with the brain: he was ſupported by other able anatomiſts. The old opinion was revived by M. *Bouillet Eléments de Medecine pratique.*

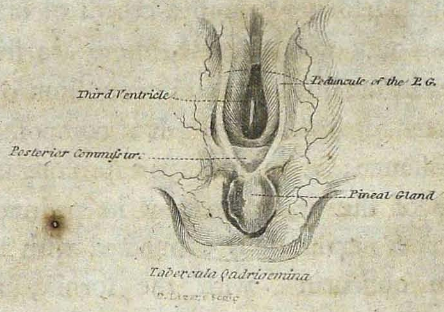
‡ See Littre, Mem. de l'Acad. des Sciences, 1707.

bercles. The tubercula quadrigemina are not in the cavities or ventricles of the brain, but are ſeen upon lifting and turning forward the poſterior lobes of the cerebrum from the cerebellum.

Theſe four tubercles are behind the third ventricle, and above the fourth. As they are immediately in the center of the brain, they form a kind of commiſſure, and they both communicate with the tubercles, from which the tractus opticus emerge. The uppermoſt two are the NATES, the lower are the TESTES; the former are leſs white than the latter. A little under the inferior tubercle, we find ſometimes a ſmall tract of medullary matter, which extends to the thalami nervorum opticorum, and the crura cerebri. And from the lower part of the teſtes there project backwards, connecting itſelf with the crura cerebelli, a thin medullary lamina, which is the VALVULA VIEUSSENII, PROCESSUS A CEREBELLO AD TESTES, or VELUM INTERJECTUM. Behind the poſterior tubercle, or from this medullary lamina itſelf, the fourth pair of nerves take their origin. Sometimes thoſe four tubercles are of the ſame ſize; ſometimes the poſterior, ſometimes the anterior tubercles, are the larger: a perpendicular ſection of them ſhows a mutual communication of ſtriæ of medullary and cineritious matter, but thoſe are faintly ſeen only.

THE

THE PINEAL GLAND.



THE pineal gland is seated above the tubercula quadrigemina, and behind the thalami nervorum opticorum; it is fixed, says Winslow, like a button. It consists of cineritious matter covered with the pia mater; its base is surrounded with medullary matter; it adheres firmly to the velum, and is apt to be displaced or torn from its pedunculi in lifting that membrane. It is a small soft greyish body, irregularly round, or of the figure of a pine-apple; or, of all things, likest the heart of a frog *. Its pedunculi, or footstalks, pass out from a transverse medullary base, which unites it to the posterior commissure. Those pedunculi pass on each side to the thalami nervorum opticorum (leaving a passage under and betwixt them to the fourth ventricle). Their extremities pass forward upon the internal

* Ruysch considered the substance of this gland as different from that of the cerebrum or cerebellum, and different, also, from all other glands.

 surface

ſurface of the thalami nervorum opticorum, and are united to the anterior crura of the fornix.

Vicq d'Azyr remarks, that although the ideas of Galen and Deſcartes *, and a crowd of others are remembered only with ridicule, there are ſtill ſome peculiarities in the ſituations and connection of this body, which mark its importance. It is compoſed of cineritious ſubſtance; it is in fact a prolongation of the ſubſtance of the brain, and by its pedunculi, which are like two nerves, it is connected with the thalami nervorum opticorum, with the fornix, and conſequently with the corpus calloſum, the hypocampus and corpora albicantia, which are themſelves the center of union to ſeveral medullary cords; therefore he concludes that the pineal gland muſt be an important organ †.

The pineal gland has often in it little peculiar grains and calculi ‡. It has a great variety of form and ſize; I have

* Alluding to their opinion of this being the ſeat of the ſoul; Willis impoſed upon this part a lower office, "Ejuſque munus non "aliud omnino eſſe quam aliarum glandularum quæ juxta vaſorum "ſanguiferorum concurſus diſponuntur; nempe ut humores ſeroſos, "a ſanguine arterioſo depoſitos, excipiat, et in ſe retineat; donec "aut *venæ* depletiores factæ eoſdem reſorbeant, aut lymphæ ductus "(ſi qui adfuerint) eos extra convehant." Willis, p. 46.

† Mem. de l'Acad. Royal, An. 1781, p. 533. See Obſerv. par M. Mechel ſur la gland pineale, ſur la cloiſon tranſparente, et ſur l'origine du nerf de la ſeptieme paire. L'Acad. Berlin, 1765.

‡ "La parte anteriore della baſe n'è ordinari amente midollare, "e qui appunto l' ho moltiſſime volte veduta geſſata, oſſoſa, tarta"roſa e friabile, vizi, che ho trovati anche molte volte nei picciuoli." Malacarne, part ii. p. 81. *Acervulus*; Meckel, Mem. de l'Acad. des Sciences

I have found it ſurrounded with pus in an ideot-boy, who was accuſtomed to wander about the Leith glaſs-houſes. He died with ſymptoms of hydrocephalus, and in his ventricles, accordingly, there was found much fluid. Malacarne gives a caſe of its having degenerated into hydatids, like a cluſter of grapes. It has not been found upon diſſection in ſome caſes.

POSTERIOR COMMISSURE.

The baſe of the pineal gland is connected with the poſterior commiſſure of the brain. This commiſſure is ſeen like a cord, or like the anterior commiſſure, towards the back part of the third ventricle, before the tubercula quadrigemina, and above the iter ad quartum ventriculum. Betwixt this commiſſure and the baſe of the pineal gland, we have to obſerve two or three medullary filaments, not paſſing from the gland, but lying parallel to the commiſſure. But this part of the brain, which appears like a cord, does not deſerve the name of commiſſure; it does not paſs on each ſide into the ſubſtance of the brain as the anterior one does; it is loſt in the neighbouring border of medullary matter, and is merely this matter reflected, ſo as to have a rounded edge.

Sciences a Berlin, 1755, fig. 1. b. b. Vicq d'Azyr, tab. xxvii. "Super medulloſum conarii vinculum vel in ipſo vinculo, vel in ipſo "denique acervulo, plerumque vero ante acervulum iam in fetibus "inmaturis peculiares quidam lapilli, mox maiorum acervulum, mox "vero duo vel tres minores acervulos conſtituentes, helui, ſemiperlu-"cidi, iunioribus ſemper pallidiores, annoſioribus fuſciores, infantibus "ob coloris languorem et perluciditatem difficiles cognitu ſiccati al-"bidiores et opaciores inveniuntur." Soemmerring, p. 63.

OF THE FOURTH VENTRICLE.

THE fourth ventricle deſcends perpendicularly before the cerebellum; it is incloſed above by the valvula cerebri, below by the medulla ſpinæ, and on the right and left by the crura cerebelli.

When we paſs our probe obliquely backwards and downwards under the poſterior commiſſure, it paſſes into the ITER AD QUARTUM VENTRICULUM, or AQUEDUCT of SILVIUS. This paſſage to the fourth ventricle, goes before the tubercula quadrigemina. The VALVULA VIEUSSENII, it was ſuppoſed, prevented the falling down of the moiſture of the other cavities into the fourth ventricle *: it is more properly called the PROCESSUS CEREBELLI AD TESTES, being a medullary lamina ſpread over the ventricle and betwixt the crura cerebelli, as they riſe from the ARBOR VITÆ, or the internal medullary part of the cerebellum.

From the aqueduct there is continued down upon the fore part of the fourth ventricle a kind of fiſſure; which Veſalius, conceiving it to have ſome reſemblance to a writing quill, called CALAMUS SCRIPTORIUS. The ſame fiſſure or furrow is continued down ſome way upon the ſpinal marrow.

There paſs up obliquely outwards, on each ſide of the calamus ſcriptorius, medullary lines, three or four in number, but ſometimes ſeven are obſerved †. One of theſe fibres aſcends to the valvula Vieuſſenii; ſome are the origines of the auditory nerve, and one or two ſtriæ go to form part of the eighth.

* Alveus Silvii.

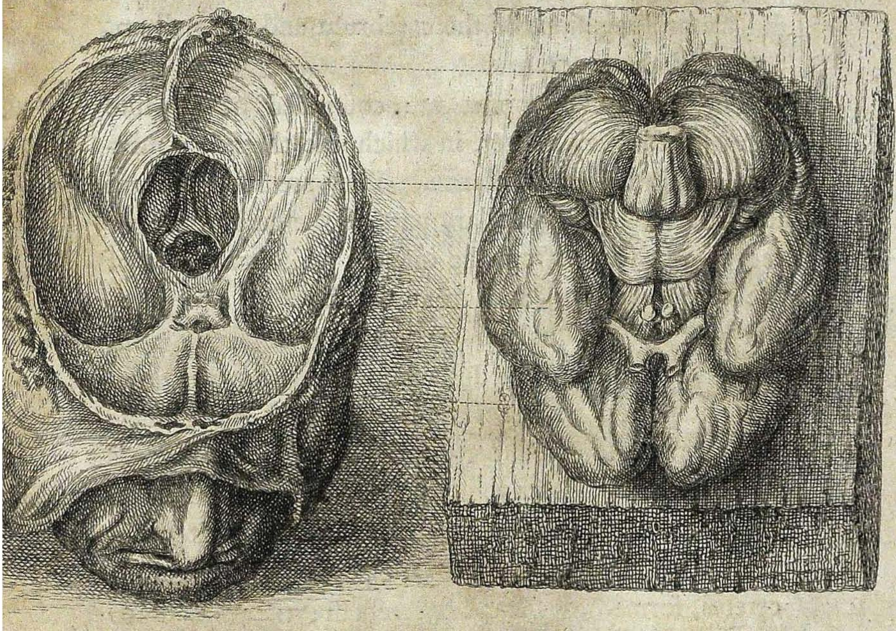
† Haller, Phyſiol. tom. iv. p. 78.

In

In the fourth ventricle, as in the others, are ſome convolutions of the plexus choroides; theſe are on each ſide at the termination of the vermis; they are continued out upon the baſe of the brain, and are ſeen expoſed betwixt the ſeventh and eighth pair of nerves.

OF THE BASE OF THE BRAIN AND ORIGIN OF THE NERVES.

Relation of the Brain & Scullcap.



We have anticipated much that might have fallen to be treated of in this diviſion of our ſubject; but my intention here is to give a connected view of the parts, as ſeen when we have raiſed the brain from the ſcull, and when, having the baſe preſented to us, we are about to enumerate the origines of the nerves.

The

The firſt appearance which ſtrikes us is the great proportion of the medullary matter in the baſe of the brain; the whole ſurface of the brain, while ſeen from above, was cineritious, but now the centrical medullary part of the brain is ſeen emerging from the envelopement of the cineritious matter, and, gathering together from the ſeveral internal medullary proceſſes of the brain, it concentrates the eſſential properties of the encephalon, and is fitted to give out the ſeveral nerves. Thoſe great medullary prolongations of the cerebrum and cerebellum, are called the crura.

The CRURA CEREBRI are compoſed of a white fibrous medullary matter, in which alſo there is a mixture of cineritious ſubſtance. They are formed from the whole central medullary part of the cerebrum; or more immediately from the inferior and lateral part of the corpora ſtriata, and from the ſuperior and internal part of the thalami nervorum opticorum; and, from the conflux of medullary matter, from the anterior and poſterior lobes of the cerebrum. From all theſe various parts the medullary matter, paſſing downwards and backwards, forms the crura *. The crus of either ſide of the brain, contracting their diameters, unite at an acute angle, and are united to the pons varolii, or nodus cerebri, formed by the crura cerebelli; they paſs on to form the medulla oblongata, and, as they unite with it, they raiſe it into the eminences, called Corpora Pyramidalia. In thoſe proceſſes of the cerebrum, the cineritious and medullary ſubſtances mingle with ſome degree of confuſion;

* I ſpeak ſtill of the relation of thoſe to each other, according to their natural ſituation in the ſcull.

confusion; so that when we make a section of the crura cerebri near to their union with the pons varolii, we observe a substance of a dark-brown colour, surrounded with white or medullary matter. In the angle of the union of these crura cerebri, behind the corpora albicantia, and before the protuberance of the pons varolii, we observe a matter less perfectly white than the surrounding medullary substance, which forms a floor to the third ventricle. This part is perforated with a great many holes, and is the *substance perforée* of Vicq d'Azyr *, and gives origin to the third pair of nerves along with the crura themselves.

CRURA CEREBELLI.

THE crura cerebelli are more exposed than those of the cerebrum; the latter lying deeper, and being comparatively smaller. They are formed by the union of the internal medullary part of the cerebellum, or the arbor vitæ. They are altogether composed of medullary matter, except near the pons varolii, where we observe a mixture of coloured striæ.

PONS VAROLII.

THE PONS VAROLII, TUBER ANNULARE, or NODUS CEREBRI is formed by the union of the crura cerebri and cerebelli; those names are almost descriptive of its shape

* Vicq d'Azyr makes three divisions of this *substance perforée*—1st. At the roots of the tubercles, from whence the first pair of nerves emerge betwixt the roots of those nerves, and near the origin of the optic nerves. 2d. Those I mention betwixt the crura cerebri. 3d. On the outer contour of the optic thalami.

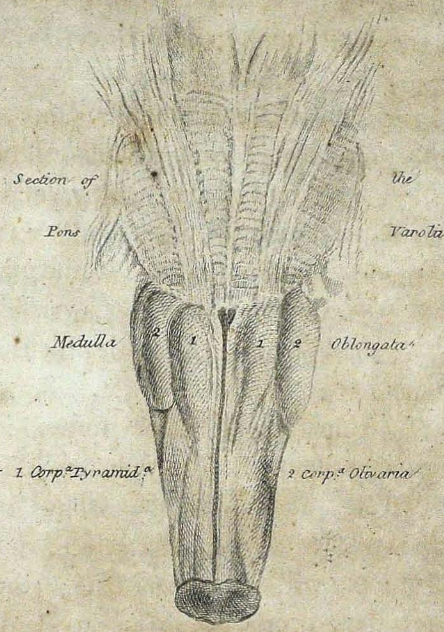
ſhape and relation to the other parts. Varolius, looking upon thoſe parts inverted, compares the crura cerebri to a river paſſing under a bridge, and thence named it Pons. The nodus cerebri, again, is a name well applied, ſince this medullary emminence has much the appearance of a knot caſt upon the medullary proceſſes of the cerebrum, and is in fact the central union of the elongated medullary matter of both cerebrum and cerebellum.

On the ſurface of this medullary protuberance there are many tranſverſe fibres, which, uniting in a middle line, form a kind of rapha, which, upon a ſuperficial ſection, ſhows a longitudinal medullary line. The fibres upon the ſurface of this body are uniform and parallel to each other in the moſt projecting part; but upon the ſides, they diſperſe to give place to the fifth pair of nerves and crura cerebelli.

A deeper incision of the pons varolii, while it ſhows the intimate union of the crura cerebri, cerebelli, and pons varolii, alſo ſhows the white medullary tracts which extend from the crura cerebri through the pons varolii to the corpora pyramidalia; part of theſe paſs through the LOCUS NIGER CRURUM CEREBRI, and can be traced to the corpora ſtriata. We ſee alſo the tranſverſe fibres of the medullary and cineritious ſubſtance, which make a right angle with thoſe longitudinal tracts.

MEDULLA

MEDULLA OBLONGATA.



THE medulla oblongata is the prolongation of the ſubſtance of the crura cerebri and cerebelli, and the pons varolii; it is conſequently the continuation of the encephalon, which, after giving off the nerves that paſs through the foramina of the ſcull, enters the

canal of the ſpine to ſupply the ſpinal nerves. The medulla oblongata is marked at its upper end by a deep ſulcus dividing it from the pons varolii; but towards the ſpinal cavity it decreaſes in thickneſs, and there is no natural diſtinction or ſulcus to mark the point where the medulla oblongata ends, and the medulla ſpinalis begins; nor perhaps is the medulla oblongata to be conſidered in any other light than as the beginning of the ſpinal marrow. When it paſſes the foramen magnum, it ceaſes to be called the medulla oblongata.

We have to obſerve four emminences upon the medulla oblongata, viz. two corpora pyramidalia, and two corpora olivaria. The CORPORA PYRAMIDALIA, ſo called from their ſhape, are thoſe in the middle. There is formed betwixt them and the pons varolii (being three tubercles placed together) a little ſulcus, which ſome have called the FORAMEN CÆCUM. Betwixt theſe emminences there is a longitudinal fiſſure, in the bottom of which there may be obſerved tranſverſe little cords, which are like commiſſures connecting the two ſides of the medulla oblongata.

The CORPORA OLIVARIA lie upon the ſides of the corpora pyramidalia. They are in ſome degree, like them, limited by the ſulcus which bounds the pons varolii, rounded above and bulging, but gradually ſubſiding, at their lower part, into the level of the medulla ſpinalis; yet they are internally different, for anatomiſts had obſerved a mixture of a yellow or cineritious coloured matter in the corpora olivaria, but Vicq d'Azyr has obſerved a regular oval medullary ſubſtance, or body ſurrounded with cineritious coloured ſubſtance, like a miniature-repreſentation of the cerebrum itſelf; he

he calls it CORPUS DENTATUM EMMINENTIÆ OLIVARIS.

MEDULLA SPINALIS.

THE medulla ſpinalis, from its ſtructure, its two ſubſtances, its membranes, and its uſe, as evident in the conſequences of injury, muſt be conſidered as an elongation of the brain. Its name implies its ſituation contained within the tube of the ſpine. Though chiefly compoſed of medullary matter, it is not entirely ſo; for there is an irregular, central, cortical ſubſtance, through its whole extent, having ſomething of a crucial form in the ſection of this part *. There are continued down from the calamus ſcriptorius behind, and the rima, formed by the corpora pyramidalia, before, two fiſſures which divide the ſpinal marrow into lateral portions. On the back part, however, the fiſſure is very little diſtinguiſhable. Into the anterior one the little veſſels penetrate to ſupply the cineritious matter with blood. The ſpinal marrow diminiſhes in thickneſs as it deſcends in the neck; but below the giving off of the brachial plexus it again enlarges, then continues gradually to diminiſh.

The tube of the vertebræ is connected by a ſtrong ligamentous ſheath, which runs down the whole length within the tube. The dura mater, after lining the internal ſurface of the cranium, goes out by the great foramen, and forms a kind of funnel; at the occipital

* The ſurface of the ſpinal marrow has alſo been obſerved to be of a darker colour, and in large animals diſtinctly cineritious. (Dr. Monro's Nervous Syſtem.)

foramen

foramen it is united firmly to the ligament. Under this, however, it forms a ſeparate tube. The tunica arachnoides again adheres looſely, having a kind of ſecretion within it, while the pia mater cloſely embraces, and is intimately united to the medullary matter.

From betwixt the ninth nerve and vertebal artery to the ſecond and third lumbar nerve, there is a membraneous connection betwixt the lateral part of the ſpinal marrow and the dura mater of the ſpine. From the manner of its connection to the dura mater, by diſtinct ſlips irregular and pointed, it is called the Ligamentum Denticulatum, or Dentatum.

SCHEME AND GENERAL DESCRIPTION OF THE ORIGINES OF THE NERVES OF THE ENCEPHALON AND SPINE.

In enumerating the nerves which paſs from the cranium, I ſhall keep to the old way of Willis, counting only nine nerves of the encephalon. I do not find that the ſubdiviſions of the nerves in this claſſification, and the deſcription of the ſeveral faſciculi, of which the pairs of nerves are compoſed, cauſe intricacy. It rather, I am from experience convinced, connects ſome circumſtances with many of the pairs of nerves thus enumerated, to which the memory of the ſtudent can attach. The common enumeration ſeems a natural one; it ſerves well the purpoſe of diſſection, and conſequently will never be entirely exploded. The uſe of new claſſifications and arrangements, and names, whilſt we muſt alſo retain the old, adds much to the intricacy of demonſtration.

From

From the olfactory nerve to that which paſſes out betwixt the cranium and firſt vertebra, there are nine nerves *.

1ſt pair—Olfactory nerves.	*Carunculæ mamillares Math.* de Grad. *Proceſſus ad nares.* Gonth d'Andernac. 8um par, Spigel. 1ſt pair of Willis.
2d pair—Optic nerves.	*Nervus viſivus, ſeu viſorius.* Carpi. 1^{m} *par antiquorum.* 2d pair of Willis.
3d pair—Motores oculorum.	2um par, Fallop. et Veſal. Nerfs moteurs communs des yeux.—Winſlow. 3d pair of Willis.
4th pair—Trochlearis.	*Minor propago* 3^{ii} *Paris, id eſt* 5^{i} *recentiorum, Fallop.* *Gracilior radix* 3^{ii} *Paris, id eſt* 5^{i} *recentiorum.* Veſal. *Nervus qui prope nates oritur.* Euſtach. 9um par Cortes : et Columb. 4th pair; or, pathetic nerves of Willis.
5th pair—Trigemini.	*Nervus anonymus trigeminus multorum.* 3um par Fallop. et Veſal. 5th pair of Willis. Trijumeaux of Winſlow.
6th pair—Abductores.	4um par Fallop. *Radix gracilior* 5^{i} *Paris, id eſt* 7^{i} *recentiorum Veſal.* *Par oculis proſpiciens.* 8um *par* Capp. Bauhini. 6th pair of Willis. Nerfs oculo-muſculaires, ou moteurs externes de Winſlow.
7th pair — Auditory nerves.	2um par Alexand. Benedict. 4um par Carol. Stephan. 5um par Veſal. et aliorum. 6um par V. Horne. Portia mollis, of the Moderns.
7th pair — Nervus communicans faciei.	*Diſtinctus a molli nervus.* Fallop. *Portio, ut præcedens,* 5^{i} *Paris, id eſt* 7^{i} *recentiorum.* Veſal. Portio dura, of the Moderns. Le petit ſympatheque, of Winſlow. Facial nerve.

* In the following table, I am of courſe much indebted to the ſynonymie of Vicq d'Azyr.

8th pair	Gloſſo-pharyngeus.	*Qui ad muſculos linguæ et faucium tendet. Fallop.* Le rameau lingual de la 8^{e} paire of Winſlow. 8th pair d'Anderſch. Superior faſciculus of the 8th pair of Willis. *Gloſſo Pharyngeus.* Haller.
	Par vagum.	*Nervus ſextus* Galeni *et aliorum.* 5^{a} *conjugatio* Carol. Stephan. 7um par Alex. Benedict. 6um par Caſp. Bauhini. 9um par Bidloo et Anderſch. 8th pair of Willis. Le moyen ſympathique of Winſlow.
	Spinal acceſſory nerve.	The ſpinal nerve.
9th pair—Lingual.		7um par Fallop. Veſal *et aliorum.* 11um par Bidloo. 10um par Anderſch. *Par linguale medium, vel nervus lingualis medius.*—Haller. Soemmering *et aliorum.* The hypogloſſal, *ſublingual*, or guſtatory. The 9th pair of Willis.
10th pair—Suboccipital nerve.		10th pair of Willis. 1ſt ſpinal, or cervical nerve, of Haller. I count this the firſt cervical nerve.

FIRST PAIR; OR, OLFACTORY NERVES *.

THE olfactory nerve is ſoft and pulpy, and ſoon reſolved by putrefaction; therefore, we ſhould not be ſurpriſed that it was neglected by the Ancients †. It adheres

* In the preſent enumeration and deſcription of the nerves, we attend chiefly to their relation to the brain. In the introduction to the next part of this volume, they will be found arranged and claſſed previous to the detail of their minute diſtribution.

† The olfactory nerve is in brutes a large prolongation of the ſubſtance of the brain, and is the proper mamillary proceſſes. Their olfactory nerves have a cavity or ventricle in them, and it was natural for the Ancients to imagine that the pituita of the brain was from

heres firmly to the lower ſurface of the anterior lobe of the brain, but it does not take its origin here. It is of a triangular ſhape, as if moulded to the ſulcus in which it lies; by being ſometimes ſunk into the ſulcus more or leſs on one ſide than the other, it has the appearance of being larger on one ſide than the other. It takes its origin by three medullary tracts *; 1ſt, From the corpus ſtriatum; 2d, From the medullary matter of the anterior lobe; 3d, From the fore and under part of the corpus calloſum †. When a ſection is made of it, we obſerve in it a cineritious portion.

Towards the fore-part, this nerve expands into a bulbous oval lobe, which conſiſts of a ſemi-tranſparent cineritious ſubſtance. This lies upon the crebriform plate, and from it are ſent down the nerves which expand upon the membrane of the noſe, and compoſe the organ of ſmelling ‡.

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from this ſtrained through the crebriform plate into the noſe. Veſalius proved the abſurdity of this opinion; it was, however, revived by Dulaurens, who was perhaps more of a courtier than an anatomiſt. But Willis is not much better, when he deſcribes the proper uſe of theſe nerves. He ſuppoſed the crebriform plate of the æthmoid bone to prevent bodies from paſſing up into the brain ("ne quid aſperi "aut moleſti cum illis una ad cerebrum feratur"); while the lymph in thoſe nerves corrected the two pungent odours; "odorum ſpecies "demulcere eaſque ſenſorio quadantenus præparare."

* Or we ſay that the external root generally ſplits, having two faſiculi. See Prochaſka, tab. 1.

† Vicq d'Azyr, M. de l'Acad. Roy. 1781.—"Breviores fibræ "medulloræ cum longioribus exterioribus connexæ nonunquam cine-"ream particulam excipiunt." *Soemmerring.*

‡ Duverney has ſhown us, that thoſe nerves paſſing through the crebriform plate become firm nerves, like thoſe in the other parts of the body. They are to be ſeen by tearing the membrane of the noſe from the bone.

SECOND PAIR; OR, OPTIC NERVES *.

The optic nerves arise from the posterior part of the optic thalami, and also (and perhaps more directly †) from the tubercula quadrigemina. When we trace the optic nerves backwards into the tractus opticus, we find them taking a circle round the crura cerebri, then enlarging, each forms a tubercle towards the back part of the thalamus opticus, and afterwards unites with the posterior tubercle of the thalamus opticus; at the same time a division stretches towards the testes, while betwixt the posterior tubercle of the thalamus opticus and the nates, there is an intermediate communication. When those tubercles are fairly exposed by separating the middle lobes of the brain, and dissecting away the tunica arachnoides and pia mater, they are seen smooth, and formed of medullary matter; which is uniformly continued from the one to the other, following their gentle convexities with an uninterrupted surface. Within those tubercles is a mixture of cineritious and medullary matter, and, especially, there is a distinct streak which passes from the tractus opticus to the nates.

Thus there is a communication betwixt the nates and testes, and the optic nerve; but we must still consider the nerve as arising in a peculiar manner from the thalamus opticus, while at the same time it receives additions from the crura cerebri, where the nerve adheres closely to the crura.

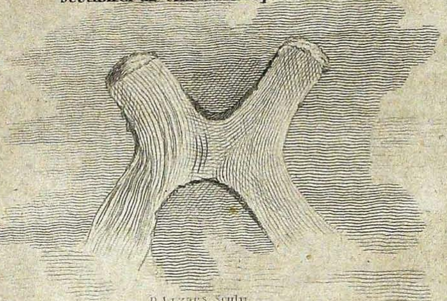
* The optic nerves were the first pair of Galen and many of the elder anatomists, they being ignorant of the olfactory nerves.

† "Les nerfs optiques naissent en arriere des eminenees nates et "testes vers la partie posterieure de celles que l'on nomme les couches "des nerfs optiques." *Sabatier.*

Tracing

Tracing the optic nerves from their origin in the brain towards their exit from the ſcull, we find them approaching gradually and uniting juſt before the corpora albicantia and the infundibulum.

Section of the Union of the Optic Nerve.



D. Lizars. Sculp.

Since the days of Galen, it has been a diſputed point, whether there is a union ſimply of the nerves, or a decuſſation. Fiſhes have the nerve ariſing from one ſide of the brain paſſing to the eye of the other ſide: they croſs, but they do not unite. Birds have but one optic nerve ariſing from the brain, which ſplits and forms the right and left optic nerves. Veſalius diſſected a young man at Padua, who had loſt his eye a year before; at the ſame time he diſſected a woman, whoſe eye had been loſt a long while. In the latter he found the nerve of that ſide ſmaller, firmer, and of rediſh colour, through all its extent. In the young man he obſerved no effect upon the nerve. He alſo gives a plate of an inſtance in which he found the optic nerves paſs on to the eyes of the ſame ſide from which they take their origin, without adhering at all.

 Valverda,

Valverda, a phyſician of Spain, who travelled into Italy, and ſtudied the Works of Veſalius and Human Diſſection, ſays, that at Venice he had frequent opportunities of aſſuring himſelf that there was no decuſſation; for robbers were puniſhed for the firſt offence by loſing one of their eyes; and for the ſecond by death. Riolinus, Roleſinkius, and Santorini, give obſervations of the nerve of the injured eye being ſmall and ſhrivelled, and of their having traced them paſt their union to the ſame ſide of the brain with the eye to which they belonged. Vicq d'Azyr, who, of all authors I conceive to be the beſt authority upon ſuch ſubjects, is decidedly of opinion that there is no decuſſation. Zin alſo agrees with the opinion of Galen, that there is an adheſion and intimate union of ſubſtance, but no croſſing of the nerves. Soemmerring deems it ſufficient to point out the authorities on both ſides of the queſtion, while he has no decided opinion whether there be a perfect decuſſation or not *. Porterfield, while he allows the intimate union of the optic nerves, has ſeveral obſervations, proving that they have no interſection or decuſſation.

Sabatier, encouraged by the authority of Morgagni, ſays, that he could trace the affection of the nerve of the injured eye no farther than to the union. He diſcredits the accounts of their having been traced to the ſame ſide of the brain, and believes the aſſertions to be the conſequence of previous opinion and prejudice.—There are certain obſervations of Valſalva, Cheſelden, and Petit, which ſeem to prove, that where the brain is

* "Ergo, utrum omnes nervorum fibræ, an quædam tantum mu-"tuo ſe ſecent, certe ſtatui nequit."

injured

injured, it is the eye of the oppofite fide that is affect-ed *. After their union the optic nerves are much contracted in diameter; ftill the optic nerve, is the largeft of the head, excepting the fifth pair. It is the firmeft of all the nerves of the fenfes, but fofter than the other nerves †.

What remains to be faid of the optic nerves, falls more naturally to be treated of when fpeaking of the organ of vifion.

THIRD PAIR OF NERVES; MOTORES OCULORUM.

The third pair of nerves arife from the internal margin of the crura cerebri, and the perforated medullary matter which is betwixt the crura. The delicate filaments of this nerve cannot be traced far into the fubftance of the brain, but ftill we may obferve them fpreading their filaments, and traverfing the dark coloured fpot which we have already mentioned to be vifible in the crura cerebri. Some anatomifts have faid, that the third pair of nerves had an origin alfo from the nates and teftes. Ridley defcribes them as rifing from the pons varolii ‡.

In relation to the arteries, thofe nerves are betwixt the pofterior artery of the cerebrum, arifing from the divifion of the bafilar artery and the anterior artery of

* If Petit and others are proving that the optic nerves are affected in the fide oppofite to the injury of the brain, they are proving that they have no decuffation; for if they had, it would counteract that effect, which, from the ftructure of the brain, they muft have in common with the other nerves.

† Soemmerring.

‡ They feem to come from the angle betwixt the crura cerebri and pons varolii. They are flat near their origin, but become round and firm.

the cerebellum *. They diverge from each other as they proceed forwards, and each penetrates under the anterior point of the tentorium by the fide of the cavernous finus, and paffes through the foramen lacerum. In the general defcription it is fufficient to fay, that they are diftributed in common to all the mufcles of the eye.

THE FOURTH PAIR OF NERVES.

The fourth pair of nerves, pathetici, or trochleares, are the fmalleft nerves of the encephalon, being not much larger than a fewing thread. This nerve comes out from betwixt the cerebrum and cerebellum, paffes by the fide of the pons varolii, and after a long courfe pierces the dura mater behind the clynoid procefs, runs along for fome way in a canal or fheath, formed by the dura mater; it then paffes through the cavernous finus, continues its courfe onwards through the foramen lacerum to the orbit, and is finally appropriated to the fuperior oblique mufcle of the eye.

The origin of the fourth pair, if we take implicitly the defcriptions of authors, feems to have a much greater variety than any of the other nerves; fo that it is common to fay, the fourth pair of nerves arife about the region of the nates and teftes †. The trochlearis

* "Cette difpofition peut expliquer pourquoi on éprouve tant de "péfanteur aux yeux aux approches du fommeil, dans l'ivreffe & "dans certains efpeces de fievre." *Sabatier*. This is a mechanical and a moft improbable way of accounting for fuch an effect.

† "Pone corpora bigemina pofteriora mox paullo fuperius, mox "paullo inferius, mox magis exteriora, mox magis interiora verfus ra- "dice fimplici, duplici, triplici, quin et quadruplici oritur.—Non- "nunquam origo ejus in cerebri valvula, nonnunquam in ipfo fre- "nulo patet ut humore ventriculi quarti alluatur." *Soemmerring*, vol. iv. p. 209.

arifes

arifes fometimes by two filaments, but more commonly by one undivided root *. This root is feen to emerge from a point betwixt the medullary lamina of the cerebellum, or valvula Vieuffenii, and the lower of the tubercula quadrigemina †.

From the connections of the parts whence this nerve arifes with the reft of the brain, it is prefumed, that this fourth pair of nerves has a very immediate and univerfal connection with the internal parts of the brain; yet there is nothing in the final diftribution of the nerve, which fhould incline us to believe that there fhould be any particular provifion in its origines.

FIFTH PAIR OF NERVES; TRIGEMINI.

THE fifth nerve of the brain arifes from the fore and loweft part of the crura cerebelli, where they unite with the pons varolii. The origin of this nerve may be divided into two portions: an anterior is fmall, and fomewhat elevated above the other. The pofterior part of this origin takes its rife a little lower than the anterior part.

* Santorini fays, they have three roots or little fafciculi. Wrifberg following Vieufens, fays, the fourth pair arifes from the valvula cerebri. Vicq d'Azyr. See Haller, faf. vii. tab. 3. "Origo alius "fimplex eft, alius duplex; quando fimplex eft, a proceffu a cerebello ad teftes exterius prodit, quam eft tranfverfa ftria, quæ eos "proceffus conjungit." Haller Phyf. vol. iv. p. 208.

† "Et fouvent ils fe confondent avec un tractus medullaire placé "tranfverfalement au-deffus de la valvule du cerveau." Vicq d'Azyr. This nerve, fays he, cannot be followed into the anterior part of the brain from its extreme delicacy, and becaufe it is formed from the medullary fubftance itfelf, without the admixture of filaments to give it ftrength. He quotes thofe words of Soemmerring:—"Continua "medulla oritur."

These

Thefe two origines of the nerve are connected by cellular membrane, and have betwixt them a little groove, in which not unfrequently an artery creeps. According to Santorini, the anterior of thefe divifions is formed by the tranfverfe fibres of the pons varolii, and the pofterior by the crura cerebelli. But this nerve appertains truly to the cerebellum; and Vicq d'Azyr could never, except in one diffection, perceive that any of its fibres arofe from the pons varolii *. The nerve of the right fide has been obferved fometimes larger than that of the left.

This fifth nerve, the largeft of the fcull, paffing forwards and downwards, flips in betwixt the lamina of the dura mater, oppofite to the point of the pars petrofum of the temporal bone. It is here firmly attached to the dura mater, and forms a flat irregular plexus. From this plexus there pafs out three great branches:—1ft, One to the focket of the eye and forehead, through the foramen lacerum; 2d, One to the upper jaw and face, through the foramen rotundum; and 3d, One to the lower jaw and tongue, paffing through the foramen ovale.

SIXTH PAIR OF NERVES; OR, ABDUCENTES †.

The fixth nerve of the fcull feems to arife from betwixt the pons varolii and medulla oblongata. In the origin of its fibres it has, however, much variety; and authors differ very much in this point of the defcrip-

* "Oritur e nodo cerebri, prope cerebellum duabus partibus, &c." Soemmerring.

† Or, motores externi.

tion.

tion *. We may ſay, however, that the ſixth pair of nerves ariſe from the corpora pyramidalia.—Sometimes the nerve riſes in two branches, which do not unite until they are entering into the cavernous ſinus †. The ſixth nerve is in ſize ſomewhat betwixt the third and fourth: it paſſes forward under the pons varolii, until near the lateral and lower part of the body of the ſphenoid bone: it thence continues its route forwards and downwards by the ſide of the carotid artery, through the cavernous ſinus: here it ſeems increaſed in ſize.—It gives off that ſmall twig which anatomiſts account the beginning of the great ſympathetic nerve. The ſixth nerve, after giving off this delicate thread, paſſes on through the foramen lacerum to the abductor muſcle of the eye.

SEVENTH PAIR OF NERVES; OR, AUDITORY.

THE ſeventh nerve ariſes from the poſterior and lateral part of the pons varolii, at the point where it is joined by the crura cerebelli.

But this ſeventh pair of Willis conſiſts of two parts; the facial nerve or portio dura, and the auditory or portio mollis; the laſt is the larger and poſterior portion ‡.

The PORTIO DURA comes out from the foſſa formed betwixt the pons varolii, corpora olivaria, and crura

* Simple as the anatomy of the nerve is, Vieuſſens, Morgagni, Lietaud, Winſlow, Sabatier—all differ in their account of the origin of this nerve in ſome little circumſtance; and Vicq d'Azyr gives ſix varieties of it.

† Sabatier.

‡ And we may add a third portion; the portio media of Wriſberg.

cerebelli *; and upon a more careful examination we find it rifing diftinctly from the crus cerebelli.

The origin of the portio mollis, of the feventh pair, is to be traced from the fore-part of the fourth ventricle †. We obferve paffing obliquely upwards from the calamus fcriptorius feveral medullary ftriæ; thofe vary in number from two to feven, and are fometimes not to be difcerned ‡. To thefe are added certain fibres arifing from the pons varolii, and as thefe fibres proceed from their origin, they become ftill more diftinctly formed into fafciculi. The whole of this portio mollis is larger than the third nerve, firmer than the firft, but lefs fo than the fecond pair: it forms a kind of groove which receives the portio dura. The portio mollis and portio dura entering the meatus auditorius internus of the petrous bone, the former is divided into

* "Foffe de l'eminence olivare," of Vicq d'Azyr.

† Prochafka, fpeaking of the fourth ventricle, continues thus:—"Super has ultimas eminentias folent medullares candicantes quafi "fibræ decurrere, a quibus proprie originem portionis mollis ner-"vorum auditoriorum faltem pro parte deducunt." (Ridley, Haller, Lobftein, cum per antiquo auctore Piccolhomini et etiam recentiffimus Soemmerring.—"Ego poftquam multoties in lineas illas "medullares in quarto ventriculo inquifiviffem, dicere poffum, non "femper illas in originem nervi acuftici mollis terminare; nonun-"quam enim paulo fupra nonunquam paulo infra definunt, ali-"quando in uno latere, & haud raro utrinque defiderantur, ita ut "ex his obfervationibus perfuadear illas medullares quarti ventriculi "ftrias ad originem portionis mollis nervi acuftici minime effen-"tiales effe." Prochafka, tab. iii. f. f.

‡ It is a curious circumftance, fhould future obfervation confirm it, which has been mentioned by Santorini, that thofe origines of the auditory nerve have been obferved particularly ftrong in a blind man, whofe hearing had been very acute.

 four

four portions which paſs to the ſeveral parts of the internal ear. The latter paſſes through the ear, and comes out by the ſtylo-maſtoid foramen behind the ear, ſpreads upon the cheek, and forms the principal nerve of the face.

EIGHTH PAIR OF NERVES.

To underſtand a very intricate demonſtration, it is neceſſary to recollect that the eighth pair of nerves, as they have a relation to the brain, conſiſts of three diſtinct nerves.—Theſe are, 1ſt, The GLOSSO-PHARYNGIAL NERVE; 2d, The PAR VAGUM; 3d, The SPINAL ACCESSORY.—Taken all together, they ariſe from the ſuperior and lateral part of the medulla oblongata.

The GLOSSO-PHARYNGIAL NERVE is only diſtinguiſhed within the ſcull as a larger filament of the eighth pair; it is however diſtinct in its courſe from the origin to the point where it pierces the dura mater: it is the uppermoſt of the fibres of this pair of nerves.—Sometimes there is a very delicate filament running parallel with its lower edge which belongs to it. It has the ſame origin with the fibres of the par vagum *.

The PAR VAGUM is compoſed of ten or twelve very ſmall filaments, which are ſometimes united into three or four faſciculi. Theſe filaments ariſe from the outer

* "Nervus gloſſo-pharyngeus faſciculo mox una, mox duabus, "quatuor, quinque fibris compoſito oritur ex ſumma atque priore "parte medullæ ſpinæ pone corpora olivaria nervum facialem inter "atque nervum vagum, nonnunquam etiam ex quarto ventriculo vel "ex cruribus cerebelli ad ſpinæ medullam, nonnunquam ſub poſteriori "ſulco nervi vagi, deductus ab eo vel diſtinctius, vel obſcurius in"terpoſita arteria, vel vena, vel arteria et vena ſimul, vel parte "plexus choreoidis, quid quod ipſa directione a nervo vago eſt di"ſtinctus." Soemmerring.

border

border of the corpus olivare, or from the lateral part of the medulla oblongata *. Sometimes they arife in a double feries like the nerves of the fpine: a few fibres are to be traced from the fide of the calamus fcriptorius of the fourth ventricle.

The SPINAL ACCESSORY NERVE comes up from the fpine to join the par vagum; it begins by fmall twigs from the pofterior roots of the fourth, fifth, fixth, and even the feventh cervical nerves. In the fize, length, and origin of thofe little flips, there is much variety: as the nerve afcends to the top of the fpine, it connects itfelf with the fuboccipital nerve; it then paffes behind the trunk of the vertebral artery, approaches the par vagum, and receives fome filaments from the medulla oblongata.—Thofe three nerves, the gloffo-pharyngeal, par vagum, and acceffory nerves, in their paffage out of the fcull are connected in a very intricate way †. They there feparate from each other. The anterior branch, the gloffo-pharyngeal nerve goes to the tongue and pharynx; the middle nerve, the par vagum, has an extenfive courfe through the body, and finally terminates in the ftomach; the loweft nerve, the acceffory, paffing into the neck, perforates the maftoid mufcle, and diftributes its branches amongft the mufcles of the fhoulder.

NINTH PAIR OF NERVES; OR, LINGUAL.

THE ninth nerve of the fcull originates from betwixt the corpora pyramidalia and olivaria. Like all the nerves of the fpine, it is compofed of feveral little filaments;

* Some filaments, according to Vieuffens, Santorini, and Soemmerring, are derived from the paries of the 4th ventricle.

† The minutiæ of which will afterwards call for attention.

ments; thoſe unite into a faſciculus of a pyramidal ſhape: ſtill thoſe filaments do not form a nerve before perforating the dura mater, but pierce it ſeverally * ; they then unite and paſs out of the ſcull by the condoloyd foramen of the occipital bone ; they are then connected with the eighth pair and ganglion of the ſympathetic nerve.—The final diſtribution of the nerve, is to the muſcles of the tongue †.

THE TENTH, OR SUBOCCIPITAL NERVE,

FROM its origin, its manner of paſſing betwixt the ſcull and firſt vertebræ, and its diſtribution, it muſt be claſſed with the nerves of the ſpine.

The nerves of the ſpine are divided into the eight cervical, twelve dorſal, five lumbar, five, and ſometimes ſix or ſeven, ſacral nerves ‡. Each of thoſe twenty-five nerves ariſes in two faſciculi, one from the fore, and the other from the back part of the ſpinal marrow. They are to be traced a great way in the length of the ſpinal marrow before they paſs the membranes. The poſterior and anterior faſciculi penetrate the dura mater ſeparately, and afterwards unite. The poſterior faſciculi of

* The ninth pair of nerves often differ very much in one ſide from the other, in regard to the origin and number of thoſe faſciculi.

† "Forſan etiam nimio ſanguine plena arteria vertebrali preſſus "læditur, ut inde hæſitantia atque reſolutio linguæ ebriorum, ex ce-"rebri phlegmone inſanientium, attonitorum explicari poſſit.—Col-"lapſa vero eadem arteria ex nimio ſanguinis profluvio lingua ob "ſanguinis forſan defectum reſolvitur.—Ex ejuſdem nervi nexu "cum nervis cervicalibus vocis jacturam poſt læſam ſpinalis medul-"læ partem quæ in cervice eſt, explicarunt."

‡ "Plerumque quinque ſunt, nonnunquam ſex, raro tres vel qua-"tuor." Soemmerring.

the

the dorſal nerve before they unite with the other, ſwell into a little ganglion. The poſterior faſciculi of the cervical nerves communicate with each other by intermediate filaments.

END OF THE ANATOMY OF THE BRAIN.

CHAP. IV.

OF THE PARTICULAR NERVES.

THE FIRST PAIR OF NERVES; OR, OLFACTORY NERVES.

WE have defcribed the three roots of this pair of nerves: their triangular form, their bulbous extremities, and their manner of perforating the crebriform plate of the æthmoid bone.

Where the foft and pulpy-like mafs of the olfactory nerves perforates the æthmoid bone, the dura mater involves them, and gives them firm coats *. There are two fets of nerves; firft, Thofe which pafs through the holes in the crebriform plate, neareft the crifta galli, run down upon the feptum of the nofe, under the fchneiderian membrane, and betwixt it and the periofteum. They become extremely minute as they defcend; and they, finally, pafs into the foft fubftance of the membrane. Secondly, Thofe filaments which pafs down by the outer fet of holes of the æthmoid plate, are diftributed to the membrane invefting the fpongy bones.

* Duverney firft obferved this courfe and firmnefs of the olfactory nerves.

 Although

Although branches of the opthalmic, pterigoid, palatine, and ſuborbital nerves paſs to the membrane of the noſe, there is reaſon to believe that they have no power of conveying the impreſſion of odours. Theſe nerves are neceſſary that the membrane may poſſeſs the common properties beſtowed by the nerves.

Upon the queſtion, whether thoſe additional branches of nerves to the noſe, aſſiſt in conveying the impreſſion of odours, there has been much controverſy. It is a ſubject upon which we might reaſon by analogy; but, certainly, little dependence can be placed upon thoſe caſes brought by either party, of diſeaſes affecting the one ſet of nerves without influencing the other. From the nature of the parts, ulceration or tumors, which deſtroy the bones of the noſe, muſt preſs equally upon the branches of the olfactory nerve, and of the fifth pair. We find that there paſs alſo to the other organs of ſenſe, ſubordinate nerves; and we know that a nerve may be modified to much variety of function; and this is evident from the nerve of taſte being a branch of the fifth pair. But it is doubtful how far a nerve may be capable of receiving at one inſtant various impreſſions. Far from conſidering diſtinct nerves ſent to the ſame organ, as affording an argument for theſe nerves receiving one uniform impreſſion, and conveying one ſimple ſenſation, it would ſeem more rational to infer, that one individual nerve cannot perform two functions, and that two functions are often required in the organs of ſenſe. I am inclined to believe, that the olfactory nerve is incapable of beſtowing common ſenſation on the membrane of the noſe; and

that

that the other nerves which ramify on that membrane, do, on the other hand, contribute nothing to the ſenſe of ſmell, as we find that the inflammation of the pituitary membrane, which raiſes the ſenſibility of the branches of the fifth pair of nerves, does in no degree make thoſe of the olfactory nerve leſs acute. The membrane is painfully inflamed, but the ſenſe of ſmell is deadened. In attending to the delicate ſenſibility of the nerves of the ſenſes, we neglect to take into account the leſs prominent, but no leſs curious peculiarities in the ſenſations, and ſympathies of the common nerves. The ſenſes of taſte or ſmell are not more diſtinct from each other, or from common ſenſation, than are the peculiar ſenſations which belong to the ſenſibility of the ſeveral viſcera. The ſtomach and inteſtinal canal poſſeſs as great a diſcrimnating power as the organ of taſte, although the ſenſations are leſs perfectly conveyed to the ſenſorium. There is a variety in the ſuſceptibility of the ſeveral organs and viſcera, a diſtinct ſenſation and proportioned action and election which is eſſential to the order and œconomy of the general ſyſtem. This is conſpicuous in the variety of the affections in remote parts, when food, medicine, or poiſon is received into the body. Theſe peculiarities in the impreſſion of which each organ is ſuſceptible, are ſo far diſtinct as to be eſſential to the due excitement of that organ; and are yet ſo general, as to connect, in one combined action, the whole ſyſtem, and to occaſion ſymphaies in remote parts, which perplex us, and give that degree of intricacy to the living actions, which renders medicine an uncertain art.

ARRANGEMENT OF THE NERVES PROCEEDING FROM THE CRANIUM.

The firſt nerve we have ſeen paſſing to the noſe.

The ſecond, third, fourth, part of the fifth and ſixth, paſs to the eye, or through the orbit.

The ſeventh nerve is that which becomes the organ of hearing.

Part of the fifth, ſeventh, eighth, ninth, and ſuboccipital nerves paſs to the bones of the face, the integuments and muſcles of the face, the jaw, and throat.

From the ſixth pair of nerves is derived the great ſympathetic; from the eighth is ſent downwards the par vagum.

The extreme branches of the fifth pair, of the ſeventh, of the eighth, ninth, and firſt cervical nerves, form a chain of connections, ſurrounding the head, face, and neck.

SECOND PAIR, OR OPTIC NERVES.

In this part of the work there is no occaſion to deliver any thing further concerning the optic nerves, than has been already ſaid of their origin, and final expanſion in the retina of the eye. It will be more proper to conſider them fully when treating of the eye in particular.

THIRD PAIR OF NERVES, OR MOTORES OCULORUM.

Theſe nerves have the name of motores oculorum, becauſe they are diſtributed to the muſcles which move the

the eye-balls. They paſs upwards from their origin; and then diverging, they penetrate the dura mater under the extreme point of the tentorium; they deſcend again by the ſide of the cavernous ſinus, and paſs out of the cranium by the foramen lacerum of the ſphenoid bone.

The nervus motor oculi having come into the ſocket divides into two branches: The INFERIOR BRANCH paſſes forward along the outſide of the optic nerve; it then divides into theſe branches:

1. To the adductor muſcle.
2. To the rectus inferior.
3. To the external oblique and to the lenticular ganglion.

But the branch of the third nerve, which, with the fifth, forms this little ganglion, is, by no means, conſtantly derived from this branch. The LESSER and SUPERIOR BRANCH of the third, is diſtributed to the rectus ſuperior oculi and levator palpebræ ſuperioris.

FOURTH PAIR OF NERVES, TROCHLEARES, OR PATHETICI.

Theſe nerves are very ſmall. Their origin, from about the tubercula quadrigemina, and their long courſe under the baſe of the brain, have been already deſcribed; after proceeding a conſiderable way, incaſed in the duplicature of the dura mater, where it forms the extreme point of the tentorium, they paſs amongſt the lamellæ of the dura mater, where it forms the cavernous ſinus. They paſs by the outſide of the third pair of nerves; turn round ſo as to be above them, and make their egreſs through the foramen lacerum of the

ſphenoid bone. They paſs forward in the orbit, undiminiſhed by the giving off of branches; and are each finally diſtributed to the ſuperior oblique muſcle or trochlearis. Sometimes, however, in their courſe, they ſend branches to unite with thoſe of the fifth pair, which paſs to the noſe, or even to the frontal nerve; but this is very rare *.

As this nerve is derived very far back from the brain, and as the parts from which it originates are leſs affected by the diſtention of the ventricles than almoſt any other part of the brain, this may be a reaſon why in hydrocephalus we ſo frequently ſee the eyes turned obliquely towards the noſe. The origins of theſe nerves being leſs affected, they will give a comparatively greater power to the ſuperior oblique muſcle. It has been obſerved alſo, that in death the power of the ſuperior oblique muſcle has a preponderance.

THE FIFTH PAIR, OR TRIGEMINI.

The tracing of the branches of the fifth pair, by diſſection, is a difficult taſk, for thoſe branches are diſtributed among the bones of the face, to the eyes, noſe, mouth, tongue, and throat. From this extenſive diſtribution the fifth nerve is neceſſarily the largeſt of thoſe that paſs out of the cranium.

It is of a flattened form †; it penetrates the dura mater at the anterior point of the petrous bone, and ſpreads flat under it. Here, under the dura mater, it is matted into one irregular ganglion; *viz.* the ſemilunar,

* Soemmerring.

† So it is ſaid, by Mickel, to reſemble the flat worm, or tænia.

lunar, or Gaſſerian ganglion. This ganglion lies on the anterior point of the temporal, and on the ſphenoidal bone. In their paſſage from the brain, the filaments, compoſing the fifth nerve, are looſe, or eaſily ſeparated; at this place, they are all found ſo ſubdivided and entangled, as to reſiſt further diviſion. The nerve here ſwells out into a greater ſize; it ſeems to be incorporated with the denſe fibres of the dura mater; it becomes of a dark red, or mixed colour; all which circumſtances have, by no means, been unobſerved by anatomiſts. Vieuſſens ſuppoſed, that the uſe of this ganglion, of the fifth pair, before it perforates the cranium, was to ſtrengthen the nerve, and enable it to withſtand the motion of the jaws! But it would rather ſeem to be a ganglion connecting in ſympathy all thoſe parts to which the nerve is finally diſtributed *.

The connection of the Gaſſerian ganglion with the dura mater, is ſo firm, that it yet remains undecided, whether there are ſent off here any nerves to that membrane; but I conceive, that there are none, and that the connection of the ganglion with the fibrous membrane, or ſheath which covers it, has been miſtaken for nerves paſſing from the ganglion to the dura mater.

From the ſemilunar or Gaſſerian ganglion, the fifth nerve divides into three great branches; whence the name of trigemini:

1ſt, The OPTHALMIC BRANCH of WILLIS, which paſſes through the foramen lacerum into the orbit.

* "Et affectum animi indicia in faciei partibus depingere adjuvet." Hirſch. Sand. Theſ. Diſerta. p. 491.

2d, The SUPERIOR MAXILLARY NERVE, which paſſes through the foramen rotundum.

3d, The INFERIOR MAXILLARY NERVE, which paſſes to the lower jaw, through the foramen ovale.

The opthalmic branch of the fifth pair.

This nerve enters the orbit in three diviſions; theſe are, the *frontal*, the *naſal*, and the *lachrymal* nerves.

1ſt, The firſt of theſe runs under the perioſteum of the upper part of the orbit, and above the levator palpebræ ſuperioris. Upon entering the orbit it gives off a ſmall branch, which paſſes to the frontal ſinus; the nerve then divides into the ſuper trochlearis, and the proper frontal nerve. The firſt of theſe paſſes to the inner part of the orbicularis oculi and frontal muſcle. The other, the outermoſt, and the proper frontal nerve, paſſes through the hole, or notch, in the margin of the orbit, and mounts upon the muſcles and integuments of the forehead. Theſe ſuperficial branches communicate with the extreme branches of the portio dura, or nervus communicans faciei.

Caſes are on record of wounds of the frontal nerve occaſioning a great variety of nervous ſymptoms, and eſpecially loſs of ſight; and it certainly marks a very particular connection and ſympathy betwixt this branch and the common nerves which paſs to the eye-ball and iris, and the retina, that blindneſs is actually occaſioned by the pricking of the frontal nerve. Morgagni ſuppoſes this to be occaſioned by the ſpaſmodic action of the recti muſcles preſſing the globe of the eye down againſt the optic nerve. It is alſo remarkable, that impreſſions acting ſolely on the retina, will convulſe the muſcles of the eye, give them irregular contractions,

and consequently distort the eye-ball and produce blindness. Such has been found to be the effect of lightning in some instances.

2d, The NASAL BRANCH of the opthalmic nerve sends off a slip or twig to form with a branch of the third pair, the LENTICULAR OR OPTHALMIC GANGLION; while the trunk of the nerve passes obliquely forwards, and inward through the orbit, and gives off one or two extremely small twigs, which join the fasciculi of ciliary nerves. The nasal branch then continues its course betwixt the superior oblique and adductor muscles; before piercing the orbital plate, it sends forward a branch, which passing under the pulley of the superior oblique muscle, joins that division of the frontal nerve which passes over the pulley. The nasal nerve then passing through the internal orbital foramen, enters the scull again, and runs under the dura mater, which covers the æthmoid bone, to pass through the crebriform plate of that bone, and again to escape from the cranium. It is finally distributed to the upper spongy bones, and to the frontal sinuses.

We thus observe such a connection of the nerves of the eye and nose, and of those distributed to the inner angle of the eye, and muscles of the eye-lids, as sufficiently accounts for the sympathy existing among those parts. We see the necessity of this connection, since the excitement of the glands which secrete the tears, the action of the muscles, and the absorption of the tears into the nose, must constitute one sympathetic action.

The LENTICULAR, OR, OPTHALMIC GANGLION, comes naturally to be considered under this division of the

the fifth pair. The lenticular ganglion is formed by a twig from the naſal branch of the fifth pair, after being united to that branch of the third pair of nerves, which goes to the levator palpebræ and the rectus ſuperior muſcles. The ganglion is of a ſquare form, and is ſituated upon the outſide of the optic nerve. The ciliary nerves paſs out from this ganglion into two faſciculi; they are ten or twelve in number; they are joined by branches of the continued naſal nerve. The ciliary nerves run forward amongſt the fat of the orbit, to the ſclerotic coat of the eye, and pierce it very obliquely in conjunction with the ciliary arteries. The ciliary nerves and arteries then paſs forward betwixt the ſclerotic and choroid coats of the eye to the iris. The iris is conſidered as the part the moſt plentifully ſupplied with nerves (as it certainly is alſo with arteries) of any part in the body. It follows, indeed, from what we formerly ſaid, that a profuſe circulation of blood is neceſſary to an accumulated nervous power.

From the connection of theſe ciliary nerves with thoſe paſſing to the noſe, Soemmerring accounts for ſneezing being the conſequence of a ſtrong light upon the eye. This may perhaps be true; but, certainly, the temporary loſs of light, from ſneezing, does not depend upon this connection of the nerves, but upon the immediate affection of the optic nerve and retina, from the concuſſion and interruption to the circulation, or upon the accumulation of blood in the eye.

2. The LACHRYMAL NERVE is the leaſt of the three diviſions of the opthalmic nerve; it divides into ſeveral branches before it enters the gland. Several of theſe branches paſs on to the tunica conjunctiva, being joined

joined by twigs of the firſt branch of the ſuperior maxillary nerve. Others connect themſelves with the extremities of the portio dura of the ſeventh pair, and with the ſuperior maxillary nerves.

The ſecond branch of the fifth pair; viz. *the ſuperior maxillary nerve.*

The ſuperior maxillary nerve, having paſſed the foramen rotundum, emerges behind the antrum highmorianum, at the back part of the orbit, at the root of the pterigoid proceſs of the ſphenoid bone. The infra orbital canal lies directly oppoſite, and ready to receive one branch, while the ſpheno-maxillary, opening into the orbit, is above, ready to receive another. The chief part, or trunk, of the nerve may be ſaid to be ſeated, and to give out its diviſions in the pterigo-palatine foſſa. Through the ſpheno-maxillary hole, the firſt branch of the ſuperior nerve is ſent into the ſocket of the eye. This twig unites with branches of the lachrymal nerve, and in general ſupplies the perioſteum of the orbit. It then ſends, through the foramen in the os mallæ, a branch which is diſtributed to the orbicularis muſcle of the eye-lid, and communicates with the branches of the portio dura of the ſeventh pair, or nervus communicans faciei. Another branch of this firſt diviſion paſſes upward from the zigomatic foſſa, in a groove of the wing of the ſphenoid bone, to the temporal muſcle, and getting ſuperficial, it accompanies the branches of the temporal artery.

Independently of this branch, which paſſes upwards to the temporal muſcle, Miekel, in his firſt diſſertation on this nerve, divides its branches into four: 1ſt, The infra

infra orbital; 2d, The defcending branch, which again gives off the vidian and nafal nerves; 3d, The palatine nerve and pofterior alveolar nerve. It was not till afterwards that he difcovered the ganglion which takes his name; and, of courfe, the previous defcription muft be imperfect. The fuperior maxillary nerve, after fending off the fmall branches which I have defcribed to enter the orbit, having fairly emerged out of the cranium, fends down two fmall branches which, uniting, form a little ganglion of a redifh colour, and of a triangular fhape, like a heart. This, the SPHENO-PALATINE GANGLION, or ganglion of Miekel, is exactly oppofite to the fpheno-palatine hole; and thofe nerves, and this ganglion are immerfed in the foft fat which fills up the fpace betwixt the fphenoid palatine and fuperior maxillary bones.

From this ganglion are fent out feveral leffer nerves, and particularly the nafal, vidian, and palatine nerves.

The SUPERIOR NASAL BRANCHES pafs by the fpheno-palatine hole to the membrane on the back part of the nofe, and to the cells of the fphenoid bone, through the fpheno-palatine hole.

The VIDIAN NERVE comes off from the back part of the ganglion, and paffes into the foramen pterigoideum backwards. It firft gives off fome fmall branches to the nofe (the fuperior and pofterior nafal nerves of Miekel); thefe perforating the bone laterally, are diftributed on the pituitary membrane, covering the vomer. The vidian nerve continuing its courfe backwards, fplits; one branch, after a long retrograde courfe through the petrous part of the temporal bone, forms a connection with the portio dura, while the other

other forms one of the roots of the great ſympathetic nerve, by joining the branch of the ſixth pair, which paſſes down with the carotid artery.

From the diſtribution of this branch of the fifth pair to the membrane of the noſe, and its connection with the ſympathetic, ſome phyſiologiſts account for the effects of odours in cauſing fainting, as the chief nerves of the heart are received from the ſympathetic. They alſo account thus for the excitement of the heart, in deliquium, by ſtimulant applications to the noſe.

The PALATINE NERVE is the largeſt of the branches ſent out from the ganglion. We have to recollect, that there are two canals paſſing down behind the palate; one anterior and larger; and another running nearly parallel to it, a poſterior and ſmaller one. The diviſion of the palatine nerve, which deſcends through the anterior palatine hole, is of courſe the larger branch; as it paſſes through the canal, it gives branches which enter the noſe, to be diſtributed upon the pituitary membrane. This larger branch, in its further progreſs through the bone, divides, and having emerged from its hole, is diſtributed all along on the left palate. The poſterior diviſion of the palatine branch, paſſing down by the poſterior palatine foramen, is diſtributed to the velum pendulum palati and its muſcles.

There is yet a third branch of the palatine nerve; *viz.* the external palatine nerve. It is the leaſt of all the branches; and, ſometimes, inſtead of coming from the ganglion, is derived immediately from the ſuperior maxillary nerve. This branch deſcends before the pterigoid proceſſes, and on the convex ſurface of the

upper

upper maxillary bone, and is diſtributed to the velum palati and uvula.

The ſuperior maxillary nerve, after ſending off the branches which form the ſpheno-palatine ganglion, paſſes obliquely downward to the infra orbital canal. In this courſe it gives off the poſterior nerve to the teeth of the upper jaw; and this again gives off a twig, which takes a courſe on the outſide of the maxillary bone, and ſupplies the gums and alveoli, and buccinator muſcle.

While paſſing in its canal, the infra orbital nerve gives off the anterior nerve to the teeth; and when it emerges from the infra orbital foramen, it ſpreads widely to the muſcles of the face, connecting itſelf with the extremities of the portio dura of the ſeventh pair, or nervus communicans faciei.

The "tic douloureux," and the "tic convulſif," of the French authors, are diſeaſes attributed to the affection of this nerve. The ſeat of the tic douloureux, is the ſide of the face, the noſtril, the cheek-bone, and root of the alveoli. Sauvage calls it the triſmus dolorificus, or maxillaris. But it is a diſeaſe not abſolutely fixed to this point of the cheek-bone; but on the contrary, from the univerſal connection betwixt the nerves of the face, it takes, ſometimes, a wide range; and the diſeaſe, I have no doubt, is ſometimes ſeated in the portio dura of the ſeventh pair. Sauvage has given to one ſpecies of it, the name of occipitalis.

It is a diſeaſe attended with extreme pain, which forces the patient to cry out in great agony. The pain is felt deep rooted in the bones of the face, and ſeems to ſpread upon the expanded extremities of the nerve; it is

is ſudden, violent, and reiterated in its attack, and it varies in the length and repetition of its acceſſion. It is confined chiefly to thoſe advanced in years, and is as violent in the day as during the night; and in the advanced ſtate of the diſeaſe, when the face is ſwelled, the ſlighteſt touch will excite the pain.

This diſeaſe is apt to be confounded with the affection of the antrum highmorianum, the tooth-ach, rheumatiſm, and clavis hyſtericus, or even with venereal pains. It has been cured by dividing of the infra orbital nerve.

In hemicrania, the affection of the three branches of the fifth nerve, is ſuch as to mark their diſtributions. There is ſwelling and pain of the face, pain of the upper maxillary bone, pains in the ear and in the teeth, difficulty of ſwallowing, and laſtly, ſtiffneſs in moving the lower jaw, in conſequence of the affection of thoſe branches which paſs up to the temporal muſcle.

There are caſes ſpoken of by Sabatier, where this infra orbital nerve being wounded, unuſual nervous affections, and even death, were the conſequence: but it would rather appear, that, independently altogether of the affection of the nerves of the face, inflammation ſpreading from the wound to the brain, had, in the examples which he gives, been the occaſion of the unuſual ſymptoms, and of the death of the patients.

Third branch of the fifth pair; or, lower maxillary nerve.

This, the laſt of the three great diviſions of the fifth pair of nerves, the largeſt but the ſhorteſt branch within the ſcull, paſſes out by the foramen ovale. It is diſtributed to the muſcles of the lower jaw, tongue, and

 glands.

glands. The trunk of the nerve having escaped from the cranium, lies covered by the external pterigoid muscle; and is at this point divided into two great branches, which again subdivide into numerous small branches; many of which it would be superfluous to describe. It is sufficient to mention them as going, 1, to the masseter muscle; 2, to the zygomatic fossa and temporal muscles; 3, to the buccinator muscle.

We regard as the two greater divisions of the lower maxillary nerve; first, The proper nerve which passes into the lower jaw; and, secondly, The gustatory or lingual nerve. The division into these two great branches is formed, after the nerve has passed betwixt the pterigoid muscles.

The GUSTATORY NERVE, immediately after its separation from the nerve of the lower jaw, is joined by the chorda tympani; or, perhaps we should rather say, a branch of this nerve, by traversing the petrous portion of the temporal bone in a retrograde direction, unites itself with the portio dura of the seventh pair, as it is passing through the ear. This nerve being seen passing across the tympanum, is the reason of its being called, CHORDA TYMPANI. The gustatory nerve, proceeding obliquely downward, sends off twigs to the salivary glands and muscles, situated betwixt the jawbone and tongue. Where it is passing by the side of the maxillary gland, it gives out some filaments which form a small ganglion, from which branches penetrate the gland. The trunk then proceeding onward betwixt the sublingual gland and the musculus hyoglossus, several twigs are sent off, which form a kind of plexus amongst the muscles and salivary glands; and com-

municating with the ninth pair of nerves, are diſtributed, finally, to the gums and membrane of the mouth.

The guſtatory nerve terminates in a laſh of nerves, which ſink deep into the ſubſtance of the tongue, betwixt the inſertion of the ſtylo and genio-gloſſal muſcles. Theſe paſs to the papillæ on the ſurface of the tongue. The ſenſe of taſte, the impreſſion of which is received upon this nerve, is ſeated in the edge and anterior part of the tongue: the action of the tongue againſt the palate forces the ſapid juice of the morſel to extend to the edge of the tongue.

The proper lower maxillary nerve, which enters into the lower jaw-bone, ſometimes called, *mundibulo labralis*, paſſes downward in an oblique direction to the groove of the lower jaw-bone. Before this nerve enters the canal of the bone, it gives off branches to the mylo-hyoideus and digaſtricus, to the ſubmaxillary glands and to the fat. The nerve then entering the bone, runs its courſe all the length of the lower jaw within the bone, and comes out at the mental hole. In this courſe it gives branches which enter the roots of the teeth, and accompany the branches of the arteries. When this lower maxillary nerve has eſcaped from the mental hole, it divides into two branches upon the chin; one of theſe is diſtributed to the orbicularis and depreſſor anguli oris, and to the ſkin and glands of the lips; the other to the depreſſor labii inferioris and integuments, and forms a kind of plexus, which ſurrounds the lips. Theſe nerves are alſo connected with the wide ſpreading branches of the portio dura of the ſeventh pair; and they are the loweſt branches of the

 facial

facial nerves, and the laſt enumerated of the intricate branches of the fifth pair.

THE SIXTH PAIR OF NERVES; ABDUCENTES, OR MOTORES EXTERNI.

The ſixth pair of nerves, as we have ſeen, ariſes betwixt the tuber annulare and the corpus pyramidale. Advancing forwards and upwards, ſometimes above and ſometimes beneath the branches of the baſilar artery, it penetrates the dura mater by the ſide of the baſilar ſinuſes. It then paſſes by the ſide of the carotid artery, and through the cavernous ſinus. Here it gives off filaments, which, clinging to the carotid artery, deſcend with it until they are joined by a branch of the vidian nerve. Theſe together form the origin of the great ſympathetic nerve. It is a diſputed point, however, whether this be a branch given out from, or received into, the ſixth pair; and in the deſcription of the ſixth pair, we might ſay, that as it paſſes the carotid artery, it receives one or more nerves which come up through the carotid hole, and encircle the nerve. The ſixth pair enters the orbit by the foramen lacerum, with the third and fourth pairs, and firſt branch of the fifth. It pierces the abductor muſcle of the eye before it is finally diſtributed to its ſubſtance.

It has been preſumed, that the ſixth nerve does not give off the ſympathetic nerve, but receives thoſe branches from it, becauſe the ſixth nerve is larger betwixt this point and its diſtribution in the orbit, than betwixt the ſame point and its origin from the brain. But I conceive, that this enlargement of the ſixth pair is

is not owing to ſuch a junction; but that, on the contrary, the nerve naturally ſwells out when it enters the ſinus, not from being ſoaked in the blood of the ſinus, but from its having additional inveſting coats, or from the coats being ſtrengthened in order to prepare the nerve for its paſſage through the blood of the ſinus.

Again, that the ſympathetic nerve ſends up thoſe branches to join the ſixth, has been preſumed from the effects of experiments on animals, of cutting or of bruiſing the ſympathetic nerve. But I ſhould not be apt to give implicit credit to the reſult of theſe experiments. Suppoſing that the ſympathetic in the neck gave an origin to the ſixth pair, ſhould not paralyſis of the abductor muſcle of the eye, and in conſequence of this, the turning of the eye towards the noſe, be the effect of cutting the ſympathetic?

We ſhall probably ceaſe to diſpute this point, when we conſider the relations and uſe of the ſympathetic nerve.

The nerves cannot be conſidered in any other light than as being formed of the ſame matter with the brain, as having ſimilar functions and powers, rather co-exiſting than dependant on the brain: and the ſympathetic nerve may be defined, a tract of medullary matter, paſſing through and connecting the head and neck, the viſcera of the thorax, abdomen, and pelvis, into one whole.

The ſympathetic nerve is ſingular in this, that it takes no particular origin, but has innumerable origins, and a univerſal connection with the other nerves through all the trunk of the body. Thoſe viſcera to which it is diſtributed are entirely independent of the

will, and have functions to perform too essential to life to be left under the influence of the will. The sympathetic nerve is thus, as it were, a system within itself, having operations to perform of which the mind is never conscious; whilst the extent of its connections occasion, during disease, sympathetic affections not easily scrutinized.

The function of this nerve is thus, in a great measure, insulated from the brain. The operations connected with it proceed, even when the brain is wanting; and it is impossible seriously to consider the sixth nerve as giving the origin to the sympathetic in any other light, than as such an expression may be subservient to arrangement, description, and general enumeration of the nerves;—a thing most necessary in so intricate a piece of anatomy.

OF THE SEVENTH PAIR OF NERVES.

The nerves of the seventh pair consist each of two fasciculi, which arise together, and pass into the foramen auditorius internus *. But these portions do not pass through the bone in union; for the anterior and lesser fasciculus, is a common nerve, which passes through to the face, and is invested, like the common nerves of the body, with strong coats. It is therefore called the PORTIO DURA †. The more posterior fasciculus

* The intermediate filaments of Wrisberg, which is betwixt these two portions of the seventh nerve, is afterwards united to the portio dura, and must be considered as one of its roots.

† Galen divided all the nerves of the brain into those two classes, *mollis* and *dura*; of which the first were those of the senses, the latter the motores corporis.

culus is the auditory nerve, and is diſtributed to the organ within the pars petroſa of the temporal bone; and in diſtinction it is called the PORTIO MOLLIS.

The PORTIO DURA, or NERVUS COMMUNICANS FACIEI, in paſſing from the brain to the internal auditory foramen, is lodged in the fore part of the auditory nerve, as in a groove. When it leaves the auditory nerve, it paſſes on through the bone, and emerges on the ſide of the face through the ſtylo-maſtoid foramen at the root of the ſtyloid proceſs, ſo as to come out juſt under the tip of the ear, covered, of courſe, by the parotid gland. The portio dura, while paſſing through the canal of the temporal bone (which is the aqueduct of Falopius), gives off a branch which unites with the vidian nerve of the fifth pair; or rather, we may conclude with the beſt authors, that it receives a branch which comes retrograde from the vidian nerve, paſſing through the ſmall hole on the anterior ſurface of the petrous part of the temporal bone. The portio dura, when it has proceeded onwards by the ſide of the tympanum, gives off one or more very minute branches to the muſcles within the tympanum, which give tenſion to the ſmall bones of the ear. A little further on, this nerve gives off a more remarkable branch, which, paſſing acroſs the tympanum, is called CORDA TYMPANI. This is the branch which, as we formerly mentioned, joins the guſtatory branch of the lower maxillary nerve. The corda tympani paſſes through the tympanum betwixt the long proceſs of the incus and the handle of the maleus; then, received into a groove of the bone, it paſſes by the ſide of the euſta-

chean tube, and after enlarging conſiderably, it is united with the guſtatory nerve.

When the portio dura, or nervus communicans faciei, has eſcaped from the ſtylo-maſtoid foramen, but is yet behind the condyle of the lower jaw, and under the parotid gland, it gives off, 1ſt, The poſterior auris. This has connection with the firſt cervical nerve, and paſſing up behind the ear, it is connected with the occipital branches of the third cervical nerve. 2d, The nervus ſtylo-hyoideus to the ſtyloid muſcles, and to unite with the ſympathetic. 3d, A branch which ſupplies ſome of the deep muſcles, and joins the laryngeal branch of the eighth pair.

The portio dura, riſing through the parotid gland, ſpreads out in three great diviſions:

1. An ASCENDING BRANCH, which divides into three temporal or jugal nerves; ſo called, becauſe they aſcend upon the jugum, or zygomatic proceſs. Two orbitary nerves, which, paſſing up to the orbicularis muſcle, branch upon it, and inoſculate with the extremities of the fifth pair.

2. The FACIAL NERVES. The ſuperior facial nerve paſſes out from the upper part of the parotid gland, acroſs the face to the cheek and orbicularis muſcle of the eye. The middle facial nerve paſſes from under the riſorius ſantorini; it goes under the zygomatic muſcle, and encircles the facial vein; it ſends branches forward to the lips, and upwards to the eye-lids, and to unite with the infra-orbital nerve. There is an inferior facial nerve, which comes out from the lower part of the parotid gland, paſſes over the

the angle of the jaw, and is diſtributed to thoſe fibres of the platyſma myoides which ſtretch up upon the face, and form the riſorius ſantorini: it paſſes on to the angle of the lips, and is diſtributed to their depreſſor muſcle. Betwixt thoſe facial nerves there are frequent communications, while they are at the ſame time united with the extremities of ſeveral branches of the fifth pair.

3. The DESCENDING BRANCHES paſs along the margine of the jaw, down upon the neck, and backward upon the occiput. Thus we ſee that the communicating nerve of the face is well named.—It is diſtributed to the ſide of the face, head, and upper part of the neck: it unites its extreme branches with thoſe of the three great diviſions of the fifth pair, with the eighth and ninth, with the acceſſory of the eighth pair, with the ſecond and third cervical nerves, and with the ſympathetic. From thoſe various connections it has been called the leſſer ſympathetic. As to the ſympathies which phyſicians have thought fit to aſcribe to the connections of this with other nerves, as laughing, weeping, kiſſing, &c. they would be tedious to enumerate, and by no means inſtructive.

The PORTIO MOLLIS of the ſeventh pair of nerves is the acauſtic or auditory nerve; which ſhall be conſidered in a more diſtinct and particular manner, when we deſcribe the other parts of the organ of hearing.

The nerves which we have now deſcribed are connected with the anatomy of the head, and circulate chiefly around the bones of the face. Thoſe we are next to conſider extend their branches to the neck, and form there a very intricate piece of anatomy, while a

claſs of them ſtill more important, paſs down to the viſcera of the breaſt and belly.

THE EIGHTH PAIR OF NERVES.

THE faſciculus, which, proceeding from the medulla oblongata, paſſes out of the cranium by the ſide of the great lateral ſinus, and which, in the view we have of the nerves upon raiſing the brain from the cranium, is properly enough conſidered as the eighth pair, conſiſts in truth of three diſtinct nerves. Theſe are the GLOSSO PHARYNGEAL NERVE, the PAR VAGUM, and the SPINAL ACCESSORY NERVE of WILLIS.

THE GLOSSO-PHARYNGEAL NERVE.

This nerve, parting from its connection with the par vagum and acceſſory nerves, perforates the dura mater ſeparately from theſe, and in many ſubjects, paſſes through an oſſeous canal diſtinct from the par vagum. When it eſcapes from the cranium, it lies deep under the angle of the jaw, and paſſes acroſs the internal carotid artery upon its outer ſide. It is to be ſeen by lifting the ſtyloid muſcles, at which point it ſends ſmall branches to the ſtyloid and digaſtric muſcles, and to join the par vagum. It ſends alſo ſome very ſmall twigs down upon the internal carotid artery; ſome of which join that pharyngeal branch* which is formed from the par vagum and acceſſory nerve.

* This is a branch to the pharynx which is formed by the par vagum and the ſpinal acceſſory of Willis. After this nerve is formed, it again forms connection with the par vagum.—Pain in the throat having been obſerved by Galen to extend to the back, Scarpa explains it on the ground of this connection with the ſpinal acceſſory nerve.

Theſe branches united form a ſmall irregular ganglion, from which again paſs off numerous branches to the conſtrictor muſcles of the pharynx.

The trunk of the gloſſo-pharyngeal nerve, after giving off thoſe nerves which paſs in the direction of the internal carotid artery, continues its courſe attached to the ſtylo-gloſſal and ſtylo-pharyngeal muſcles, to which of courſe it gives more branches, and alſo to the upper diviſion of the conſtrictor pharyngis. A diviſion of the extreme branches of this nerve terminates in the tongue, under the denomination of *rami linguales profundi*, *rami linguales laterales*, *nervi gloſſo-pharyngei**.

It appears to me that theſe branches are diſtributed amongſt the ſhort muſcles of the tongue, and perhaps to the large papillæ upon the moſt poſterior part of the tongue. Amongſt the branches of the pharyngeal nerve is to be enumerated that which turns back to join the ninth pair in its diſtribution to the tongue†. The remaining branches of the gloſſo-pharyngeal nerve, are diſtributed in innumerable filaments upon the pharynx, in which they are aſſiſted by branches from the ganglion of the ſympathetic nerve.

THE PAR VAGUM.

THE par vagum is the great and important diviſion of the eighth pair. It is the middle faſciculus of the three nerves as they lie within the ſcull. In its exit, it is ſeparated from the internal jugular vein by a thin bony plate; and ſometimes two or three fibres of the nerve

* Scarpa.

† Sabatier.

nerve paſs the bone diſtinct from the others, and afterwards unite into the proper trunk of the par vagum. Deep under the lower jaw and the maſtoid proceſs, the gloſſo-pharyngeal nerve, the par vagum, the ſpinal acceſſory, the ſympathetic nerve, the portio dura of the ſeventh, and the upper cervical nerves, are entangled in a way which will fatigue the diſſector, and may account for every degree of ſympathy of parts. The par vagum, lying behind the internal carotid artery, and as it were eſcaping from the confuſion of the ninth acceſſory and gloſſo-pharyngeal nerves, deſcends and ſwells out into a kind of ganglion*. We now obſerve three branches to be ſent off: The FIRST and SECOND PHARYNGEAL NERVES, which paſs to the conſtrictor pharyngis muſcle, and the INTERNAL LARYNGEAL NERVE. This laſt-mentioned nerve is even larger than the gloſſo-pharyngeal nerve. It is behind the carotid artery, and paſſes obliquely downward and forward. In its progreſs the principal branch paſſes under the hyo-thyroideus muſcle, and betwixt the os hyoides and the thyroid cartilage; while others, more ſuperficial, paſs down and are connected with the EXTERNAL LARYNGEAL, or PHARYNGO-LARYNGEUS; which is a nerve formed by the ſympathetic, and par vagum conjointly. The principal branch of the internal laryngeal nerve, which runs under the hyo-thyroideus, is diſtributed to the ſmall muſcles moving the cartilages. The minute extremities of this nerve paſs alſo to the apex of the epyglottis, and the glandular membrane covering the glottis. We

* *Truncus gangliformis* OCTAVI, *tumidulum corpus olivare*, Fallopii; but it is ſuſpected that in this he meant the ganglion of the ſympathetic nerve.

have,

have, at the ſame time, to remark a very particular communicating nerve betwixt this internal laryngeal nerve, and the recurrent branch of the par vagum. This branch is deſcribed by Galen. The par vagum continues its uninterrupted courſe betwixt the carotid artery and jugular vein, and is involved in the ſame ſheath with theſe veſſels. In this courſe down the neck, it ſometimes ſends back a twig which unites with the ninth pair, and when near the lower part of the neck, it ſends forward twigs to unite with thoſe from the ſympathetic nerve, which paſs down to the great veſſels of the heart, to form the ſuperior cardiac plexus*. On the right ſide, thoſe nerves to the great veſſels are in general given off by the recurrent nerve.

The par vagum now penetrates into the thorax by paſſing before the ſubclavian artery; it then ſplits into two. The main nerve paſſes on by the ſide of the trachea, and behind the root of the lungs; while the branch, on the right ſide, turns round under the ſubclavian artery; on the left, under the arch of the aorta, and aſcends behind the trachea to the larynx.

This aſcending branch of the par vagum is the RECURRENT NERVE. On the right ſide it is ſometimes double. It aſcends behind the carotid artery, and ſometimes is thrown round the root of the thyroid artery. On the left ſide, which, from its turning round the arch of the aorta, is much lower than on the right, it gives off filaments which go to the lower cardiac plexus, after having united with the branches of the ſympathetic.

* The courſe of theſe nerves to the heart, is beſt treated of with the branches of the ſympathetic nerve.

Under

Under the ſubclavian of the right ſide, alſo, there are ſent branches from the recurrent to the cardiac plexus; and on both ſides there paſs branches of communication betwixt the ſympathetic nerve and the recurrent. When the recurrent nerve has turned round the artery, it aſcends in a direction to get behind the trachea, and it lies betwixt the trachea and æſophagus. It here ſends off many branches to the back and membranous part of the trachea which pierce this poſterior part, to ſupply the internal membrane. It gives alſo branches to the æſophagus and thyroid gland. The final diſtribution of this nerve is to the larynx. It pierces betwixt the thyroid and cricoid cartilages, and ſeparates into many filaments, which terminate in the crico-arytenoideus lateralis and poſticus, and thyro-arytenoideus, and in the membrane of the larynx. We have already mentioned the branch of communication betwixt the recurrent and internal laryngeal nerves*, and Sabatier deſcribes a branch of the recurrent, which ſometimes aſcends and joins the ſympathetic high in the neck.

Two caſes, mentioned by Galen, of ſcrophulous tumors in the neck opened, where the conſequence was loſs of voice, have tempted many anatomiſts to inſtitute experiments on the recurrent and internal laryngeal nerves†.

* There is a double communication betwixt thoſe nerves; in the firſt place by this more ſuperficial branch, and again by ſeveral internal and more minute branches.

† Martin, in the Edinburgh Eſſays, Profeſſor Sue of Paris, Dr. Highton, in the memoirs of the Medical Society of London; Cruikſhanks, Profeſſor Scarpa, Arnemann, &c.

Not-

Notwithſtanding the deep ſituation of thoſe recurrent nerves, Galen ſays, they were cut in theſe caſes, and he believed that the branch of communication betwixt the laryngeal and recurrent reſtored the voice after ſome time had elapſed. Both the internal laryngeal and recurrent nerves are neceſſary to the formation of the voice. Experiments have been made upon them in dogs, and the reſult is curious; although the leſſer changes of the ſtrength, acuteneſs, and modulation of the voice could not be well obſerved in the lower animals. When the laryngeal nerve is cut, the voice is feeble but acute; when the recurrent nerve is cut, there is a relaxation of thoſe muſcles moving the arytenoid cartilages which command the opening of the glottis, and in conſequence the voice is flatter or graver, or more raucous.

The par vagum, after ſending off the recurrent nerve, deſcends by the ſide of the trachea. Before it paſſes behind the veſſels and branch of the trachea going to the lungs, it ſends minute branches which form the ANTERIOR PULMONIC PLEXUS*. This plexus is entangled in the connections of the pericardium, and is diſſected with difficulty. The branches of this plexus throw themſelves round the pulmonic arteries and veins, and follow them into the lungs.

The par vagum, paſſing on behind the root of the lungs, forms the POSTERIOR PULMONIC PLEXUS. From this alſo the nerves proceed into the lungs, by attaching themſelves to the pulmonic arteries and veins,

* I do not conceive that this plexus admits of any uſeful diviſion, or requires any diſtinction of name.

and

and broncheal arteries, and the branches of the trachea*.

The trunks of the nerve, continuing their courſe upon each ſide of the æſophagus, unite and ſplit into branches, and again unite ſo as to form a netting upon the æſophagus; theſe are the ANTERIOR and POSTERIOR PLEXUS GULÆ, or ÆSOPHAGEAL PLEXUS. The par vagum, thus attached to the æſophagus, pierces the diaphragm with it, the anterior plexus unites again into a conſiderable trunk, is attached to the leſſer arch of the ſtomach. It ſtretches even to the pylorus, and ſends its branches to the upper ſide of the ſtomach and

* *Nerves of the Lungs.*

Galen, Veſalius, and others, conceived that there were very few nerves ſent to the lungs, and that thoſe which were, went only to the membranes, and not to the ſubſtance of the lungs. They believed alſo that the diſcharge of blood from the lungs and the exiſtence of vomicæ without pain, while there was great pain in peripneumony, was a confirmation of this opinion. Fallopius corrected this idea, and ſhowed that the bronchiæ were alſo attended through their courſe with nerves. There often exiſts vomicæ and effuſions of blood in the lungs; and Haller ſays, the lungs can be lanced without the animal feeling pain, but ſtill the bronchiæ are extremely ſenſible.—Water accumulated in the interlobular cellular membrane, or the infarction of blood into it, gives no acute pain, but only a ſenſe of weight and difficulty of breathing. It is an oppreſſion in a great meaſure depending upon the return of the blood from the lungs, unchanged in conſequence of the compreſſion of the cells.—The ſenſibility of the bronchiæ, and the exiſtence of their nerves, appear in aſthma; and alſo from the pain excited by calculi, and from their irritability excited by recent ulceration, or when vomicæ are diſcharged into them.

The connection betwixt the ſtomach and bronchiæ, through the medium of the par vagum and pulmonic plexus, is evident from thoſe aſthmatic attacks which depend upon foulneſs in the ſtomach.

to

to the leſſer omentum; at the ſame time it unites with the left hepatic plexus, ſome of its branches terminate in the ſolar plexus, which ſurrounds the root of the cæliac artery. The poſterior æſophageal plexus, likewiſe uniting again into a conſiderable cord when it has come into the abdomen, ſends branches to encircle the cardiac orifice of the ſtomach; it branches alſo to the inferior ſide and great arch of the ſtomach; it ſends alſo branches to the ſplenic plexus and ſolar ganglion.

Thus we ſee that the par vagum has a moſt appropriate name, and that it is nearly as extenſive in its connections as the ſympathetic itſelf. It is diſtributed "to the æſophagus, pharynx, and larynx; to the thyroid gland, veſſels of the neck and heart, to the lungs, liver and ſpleen, ſtomach, duodenum, and ſometimes to the diaphragm." The recollection of this diſtribution will explain to us many ſympathies; for example, the hyſterical affection of the throat when the ſtomach is diſtended with flatus, the exciting of vomiting by tickling the throat, the effect which vomiting has in diminiſhing the ſenſe of ſuffocation, that ſtate of the ſtomach which is found upon diſſection to accompany hydrophobia, whether ſpontaneous, or from the bite of a dog.

OF THE ACCESSORY NERVE, OR THIRD DIVISION OF THE EIGHTH PAIR OF NERVES.

The ſpinal acceſſory nerve of Willis, is that which, taking its origins like the cervical nerves from the ſpinal marrow, aſcends through the ſpine and foramen magnum of the occipital bone, and paſſes again from the ſcull like one of the nerves of the brain. It paſſes out with the par vagum, is attached to it in its paſſage, but again ſeparates

from it when it has eſcaped from the ſcull. Under the baſe of the cranium it is attached to the ninth pair alſo. Commonly this attachment is firm; ſometimes, it is by a ſhort filament. This paraſitical nerve then paſſes behind the internal jugular vein, and paſſes obliquely downward and backward. It then perforates the maſtoid muſcle, and paſſes in a direction acroſs the neck to the ſhoulder. While it pierces, it gives nerves to the maſtoid muſcle; and after piercing, it entangles its branches with thoſe of the third and fourth cervical nerves. It then paſſes under the trapezius muſcle, and is diſtributed to it, where it is on the back of the neck and ſhoulder. From the diſtribution of this nerve we diſcover that the ſhrug of the ſhoulders is very natural; and "pourquoi les grandes paſſions de l'ame nous portent à geſticuler, pour ainſi dire, malgré nous!"*

OF THE NINTH PAIR, OR LINGUALIS MEDIUS OR HYPOGLOSSUS.

After paſſing out from the ſcull by the anterior condyloid foramen, the ninth nerve adheres to the eighth pair, by cellular filaments and the interchange of nerves. It receives alſo branches from the firſt cervical nerve, or from the branch of union of the firſt and ſecond cervical nerves. When diſſecting in the neck, we find the ninth nerve lying by the ſide of the internal jugular vein under the ſtyloid muſcles, and coming out from under the occipital branch of the internal carotid artery.

The nerve here divides, or it may rather be ſaid to give off that branch which is called the DESCENDENS NONI. The continued trunk of the nerve paſſes before

* Sabatier.

the

the external carotid artery, and forwards under the larger branches of veins in a direction tending towards the os hyoides. Here it turns upwards under the stylo-hyoideus and digastricus muscles, and betwixt the stylo-glossus and hyo-glossus. Where the nerve is near the os hyoides, and passing under the stylo-glossus muscle, it sends down a twig which passes to the fore part of the throat, and chiefly to the sterno-hyoideus and thyro-hyoideus.

The continued nerve is distributed to the muscles of the tongue and lower jaw, and glands under the jaw; and it terminates by numerous filaments, which form a net-work amongst the muscles of the tongue; to which is united part of that branch of the fifth pair which goes to the tongue*.

The RAMUS DESCENDENS NONI passes downward, and obliquely over the trunk of the carotid artery, and under the thyroid vein. In the superficial dissection of the muscles of the neck, two slender twigs of nerves will be seen to come from the side of the neck, and crossing the jugular vein, unite to this descending branch. Those twigs come from the second and third cervical nerves†; and a little ganglion or plexus is formed by their union with the descendens noni. From this center are sent out many delicate and superficial nerves to the omo-hyoideus and sterno-thyroideus muscles.

Thus we find that the ninth nerve has connections with the eighth pair of nerves, with the spinal accessory,

* This has been called *plexus cerato-basio-stylo-glossus!*

† In some instances those twigs are found to be derived from the first origin of the phrenic nerve.

 the

the ſympathetic, the cervical, and phrenic nerves. When this nerve is injured, the motion of the tongue is loſt, but the ſenſe of taſte remains unimpaired. On the contrary, when the branch of the fifth nerve going to the tongue is hurt, the ſenſe of taſte is loſt, while the mobility of the tongue remains *. Columbus knew a man who had no ſenſe of taſte, and who eat indifferently every thing preſented to him. When he died, Columbus was curious to know the cauſe of this, and he found that he altogether wanted the guſtatory nerve or lingual branch of the inferior maxillary nerve. Caſes detailed by Profeſſor Scarpa ſtill further illuſtrate this fact. A woman, ſubject to epileptic attacks in an early age, was ſeized in her pregnancy with an hemiplegia and loſs of ſpeech. From this attack, by the uſe of medicines, ſhe recovered; but in a future labour the diſeaſe recurred. Now the cure was leſs complete; for, though ſhe regained the uſe of her arms, ſhe never recovered the faculty of ſpeech, or was only capable of articulating with great diſſonance the monoſyllables, affirming or denying. Upon making her exert herſelf to ſpeak, they obſerved no motion in the tongue; and, upon applying the hand under the jaw, they could feel no motion in the muſcles of the tongue; yet ſhe reliſhed her food and drink, and had an acute ſenſe of taſte, and could ſwallow eaſily. He mentions another caſe, where the patient was attacked with a ſenſe of weight at the root of the tongue, a difficulty of ſpeaking, and copious flow

* Soemmerring de Cerebro & Nervis.

of

of ſaliva. In a ſhort time he intirely loſt the power of articulating, but retained acutely the ſenſe of taſte *.

From the extenſive connection of this nerve, particularly with the eighth and ſympathetic nerves, we ſee why tremors of the tongue and aphonia may be occaſioned by hyſteria, hypochondriaſis, colics, or worms in the inteſtines †.

OF THE CERVICAL NERVES.

FIRST CERVICAL NERVE. TENTH PAIR OF THE SCULL. SUBOCCIPITAL NERVE. This is the leaſt of all the nerves of the ſpine; it ariſes by two roots from the medulla ſpinalis. Some difference has been obſerved in the manner in which thoſe roots collect their filaments; and only the anterior root or faſciculus is deſcribed by ſome authors. The poſterior faſciculus is indeed the larger, and comes in a direction different from the general direction of the roots of the other cervical nerves. The roots of the ſuboccipital nerve are connected with the ſpinal acceſſory nerve, but ſeldom form a ganglion with it; and frequently they form a union with the poſterior roots of the ſecond cervical nerve. The fibres of the ſuboccipital nerve paſſing tranſverſely and a little obliquely upwards, go out under the vertebral artery, and betwixt it and the firſt vertebra of the neck. The little trunk of the ſuboccipital nerve, thus formed, and having eſcaped from the ſpine, riſes for a little way upwards, ſwells

* Tabulæ Neurologicæ, Auctore Anton. Scarpa.

† J. F. Will. Bachmer Comment. de 9no pare Nervorum.

into a kind of ganglion, and then divides into two branches.

The anterior of theſe branches is the ſmaller. It paſſes down upon the inſide of the vertebral artery; its filaments unite with the hypogloſſal nerve, or ninth pair, and with the ſuperior cervical ganglion of the ſympathetic, and with the firſt branch of the ſecond cervical nerve *. The larger and poſterior branch divides into eight twigs, which are chiefly diſtributed to the muſcles moving the head—to the oblique ſuperior and inferior, the recti poſtici and laterales, complexus, and ſplenius. Some of thoſe muſcular branches unite with that branch of the ſecond cervical nerve which aſcends upon the occiput.

SECOND CERVICAL NERVE. This nerve, ariſing by a double origine from the ſpinal marrow, like the other nerves of the ſpine, paſſes betwixt the firſt and ſecond vertebræ. It is larger than the laſt; and, after forming a little ganglion by the ſide of the tranſverſe proceſs of the firſt vertebra, divides into two branches.

The SUPERIOR BRANCH ſends up a conſiderable diviſion behind the projection of the tranſverſe proceſs of the firſt vertebra, to unite to the ſuboccipital or firſt cervical nerve. Several twigs paſs forward to unite with the ſuperior cervical ganglion of the ſympathetic nerve, and with ſome of the more anterior branches of the third cervical nerve, and with the ninth and ſpinal acceſſory nerves. Beſides theſe intricate connections, irregular branches of this nerve

* A very ſmall nerve is deſcribed by ſome authors as paſſing from the anterior diviſion of the nerve, into the canal of the vertebral artery.

proceed

proceed to the ſmall muſcles, moving the head and lying on the fore part of the ſpine. The *poſterior* branch of the ſecond pair of cervical nerves is chiefly a muſcular nerve. It riſes up by the ſide of the complexus, gives branches to that muſcle and to the ſplenius, and communicates with the branches of the firſt cervical. Its branches are alſo diſtributed to the upper part of the trapezius muſcle, from which they extend along the integuments, covering the occiput even to the ſummit of the head.

The THIRD CERVICAL NERVE, in the firſt place, communicates with the ſecond and fourth cervical nerves, with the ſympathetic and lingual nerves, and ſometimes ſends down a twig to unite with the origine of the phrenic nerve from the fourth cervical nerve.

From the anterior diviſion of the third cervical nerve, branches paſs to the ſplenius and complexus, and trapezius, and upwards to the ear. We may obſerve alſo a cutaneous nerve which accompanies the external jugular vein, viz. NERVUS SUPERFICIALIS COLI; the diſtribution of which is chiefly to the angle and margine of the lower jaw, while ſome of its branches enter the parotid gland, and unite with the extremities of the portio dura and other facial nerves.

The SMALL POSTERIOR DIVISION of the nerve paſſes to the complexus, ſpinalis cervicis, and multifidus ſpinæ, while at the ſame time it unites to the branches of the ſecond cervical nerve.

The FOURTH CERVICAL NERVE, coming out from betwixt the third and fourth cervical vertebræ, divides into its anterior and poſterior branches like the other cervical nerves.

The firſt goes to form, with the third and fifth cervical nerves, the PHRENIC NERVE. It ſends alſo a branch to the ſympathetic, to the integuments of the neck and ſhoulder, and to the ſupra and infra ſpinatus muſcles. Theſe are called by Soemmerring SUPERCLAVICULARES INTERIORES, MEDII, and POSTERIORES.

The great POSTERIOR DIVISION of the fourth cervical nerve, paſſes to the muſcles of the ſpine and ſhoulder, in conjunction with the branches of the third cervical nerve.

FIFTH CERVICAL NERVE.—This nerve comes of courſe from betwixt the fourth and fifth vertebræ, and from betwixt the ſcaleni muſcles. It divides alſo into two branches. The SUPERIOR of theſe paſſes backwards to the muſcles of the back and ſhoulder, and a branch formed by it; and the ſixth paſſes down under the ſcapula and ſerratus major. This ſuperior diviſion of the nerve ſends up alſo two ſmall twigs of communication with the fourth cervical nerve.

The INFERIOR DIVISION of the nerve ſends down upon the ſide of the neck a conſiderable branch to the formation of the phrenic nerve. It communicates with the root of the ſixth nerve, and ſends muſcular branches backward.

The SIXTH CERVICAL NERVE.—The muſcular branches of this nerve are large and extenſive in their courſe. They paſs into the levator ſcapulæ, extend under the trapezius, and unite with the extreme branches of the ſpinal acceſſory nerve. They are prolonged to the latiſſimus dorſi and ſerratus magnus. Branches alſo extend down behind the clavicle, and under the pectoral muſcle.

Beſides

Befides thefe branches, this nerve communicates with the fifth, and gives out an origine to the phrenic nerve; and laftly, uniting to the feventh, it paffes into the axillary plexus.

The SEVENTH CERVICAL NERVE.—This nerve goes almoft entirely to form the axillary plexus. There is a communicating nerve from the laft to this, and from that communicating branch generally there paffes off a filament to the phrenic nerve; and from the very root of the nerve there paffes off a branch to the lower cervical ganglion of the fympathetic. Irregular twigs alfo defcend from this nerve under the clavicle to the pectoralis minor and major.

The EIGHTH CERVICAL NERVE.—The greater part of this nerve paffes to the axillary plexus. It fends fmall branches to the lower cervical ganglion of the fympathetic, and to the mufcles of the breaft; which laft defcend behind the clavicle.

RECAPITULATION OF THE DISTRIBUTION OF THE CERVICAL NERVES.

UPON reviewing the defcription of thefe nerves, we find that the general tendency of their branches is backwards over the fide of the neck, to the mufcles moving the head and fhoulders. We find alfo that they are connected in a very intricate manner with the moft important nerves of the cranium. High in the neck and under the jaw, they are connected with the portio dura, with the fifth pair, with the eighth and ninth pairs, and with the fympathetic. Towards the middle of the neck they are ftill throwing their connecting branches to the defcendens noni, and fympa-

thetic, and eighth pair. The lower cervical nerves again are ſtill ſupporting their connections with the lower ganglion of the ſympathetic.

Further, we find the phrenic nerve derived (moſt frequently) from the third and fourth, and branch of communication betwixt the fourth and fifth. The AXILLARY PLEXUS is formed by the fifth, ſixth, ſeventh, and eighth cervical nerves, and firſt of the back.

OF THE DORSAL NERVES.

THERE are twelve dorſal nerves. Theſe, as we have deſcribed, are formed by two faſciculi of fibres; one from the fore, and the other from the back part of the ſpinal marrow. Theſe filaments run for ſome way ſuperficially in the length of the ſpinal marrow before they pierce the dura mater. They pierce it ſeparately; the poſterior branch firſt forms a ganglion, and then the two faſciculi are united. They are now betwixt the heads of the ribs. We muſt here recollect, that the trunk of the ſympathetic nerve, which paſſes along the cavity of the thorax, runs down behind the pleura, and paſſes before the heads of the ribs through all the length of the back. It receives, as it paſſes the interſtices of the ſeveral ribs, at each interval, a communicating nerve from the ſpinal marrow; a branch from the intercoſtal or dorſal nerves.

Thoſe communications are ſent in the following manner: the proper dorſal, or intercoſtal nerve, ſends its greater branch forwards betwixt the ribs; ſome leſſer branches pierce backwards to the muſcles of the back; oppoſite to this there goes out from each nerve the firſt branch of union with the ſympathetic, and

this union forms a firm ganglion. Sometimes there run out in this direction two ſhort branches from the ſpinal nerve, to unite with the ganglion of the ſympathetic; but more commonly there paſſes in a retrograde direction from the intercoſtal nerve, where it is about to take its courſe between the ribs, another branch of communication which joins the ſympathetic. Sometimes the dorſal or intercoſtal nerves ſend off three communicating branches to the ſympathetic.

The intercoſtal nerves paſs on betwixt the ribs, in company with the intercoſtal arteries, and reach even to the ſternum. In this courſe they ſupply the intercoſtal muſcles and triangularis ſterni, while they are at the ſame time ſending out branches, which, piercing the intercoſtal muſcles and faſcia of the thorax, are diſtributed to the muſcles on the outſide of the cheſt.—Thoſe branches which we mentioned as paſſing betwixt the heads of the ribs, and which are ſent off immediately upon the trunk eſcaping from the vertebral opening, ſupply the multifidus ſpinæ and levatores coſtarum, and other extenſor muſcles of the ſpine. Slips proceeding from the ſecond, third, fourth, and fifth intercoſtal nerves, ſend branches to the pectoral muſcles, the ſerratus anticus, and ſerratus poſticus ſuperior, trapezius, and romboides. The ſixth, and all the lower nerves of the back, ſend branches from betwixt the ribs to the latiſſimus dorſi, ſerratus inferior, and abdominal muſcles. The eleventh and twelfth are diſtributed to the diaphragm, quadratus lumborum, pſoas magnus, and iliacus internus.

LUMBAR NERVES.

The lumbar nerves are five in number. The firſt comes out under the firſt lumbar vertebra, and the others in ſucceſſion. Their trunks are covered by the pſoas magnus. They paſs very obliquely downward, and the three loweſt are of remarkable ſize.

In the general diſtribution, we may firſt remark the poſterior branches, which go backwards to the muſcles which ſupport and extend the ſpine. Again, the anterior branches; which give, 1ſt, additional branches to the ſympathetic nerve as it paſſes over the vertebræ of the loins, and by which it is ſupported and reinforced till it terminates in the pelvis; 2dly, they have frequent connection with each other, and with the laſt nerve of the back, and firſt of the ſacrum; 3dly, they ſend out branches, delicate but of great extent, to the muſcles of the loins and back, and to the abdominal muſcles and integuments of the groin and ſcrotum; 4thly, the principal anterior branches of the lumbar nerves paſs down to form (along with the great nerves of the ſacrum) the anterior crural nerve, the obturator, and the great iſchiatic nerve.

SACRAL NERVES.

The nerves which come out from the extremity of the medulla ſpinalis, or cauda equina, through the ſacrum, are in general five in number. Sometimes there is one more or leſs. The firſt diviſion of each ſacral nerve is into thoſe branches which paſs out by the poſterior foramina of the ſacrum, and thoſe which, by the

the anterior foramina, come into the pelvis. The pofterior branches are very fmall, and pafs to the mufcles fupporting the fpine; while the anterior ones are particularly large, efpecially the firft and fecond, which, with the loweft of the loins, go to form the largeft nerve of the body, the ifchiatic nerve.

It is difficult to recollect the diftribution of the feveral branches of the lumbar and facral nerves, when taken thus together; but when we deliver the defcription of the nerves of the thigh and leg, we count them, and hold them in remembrance with comparative eafe. At prefent we are beft prepared to follow the fympathetic nerve in its courfe.

OF THE GREAT SYMPATHETIC NERVE, OR INTERCOSTAL NERVE.

NOTWITHSTANDING the idea of this nerve which I have endeavoured to convey, I conceive that we muft ftill continue to fpeak of the origines of this nerve in the ufual way, for the fake of fimplicity and arrangement.

The fympathetic nerve is in general confidered as originally derived from the fixth pair; or, we may fay, it takes its origine from the fixth, where it paffes by the fide of the carotid artery, and from the vidian branch of the fifth pair. It appears without the fcull, fometimes behind and fometimes before the carotid artery, and fometimes it is double in its exit from the bafe of the fcull. Almoft immediately after it has efcaped from the fcull, it forms its firft ganglion; which is very large and remarkable, and has the name of the SUPERIOR CERVICAL GANGLION of the fympathetic nerve,

nerve. It is of a ſoft conſiſtence and reddiſh colour, and it extends from the ſcull to the tranſverſe proceſs of the third vertebra. It gradually tapers downwards until it terminates in the ſlender nerve, which in the neck is extremely ſmall. This ganglion has much variety of ſhape in different ſubjects, and may be ſaid in general to receive twigs of nerves upon the back part; it gives them out upon the fore part.

The ſuperior cervical ganglion of the ſympathetic nerve receives nerves from the ſecond, third, and fourth cervical nerves, and even ſometimes from the root of the phrenic nerve. It has alſo connections with the hypo-gloſſal, par vagum, and gloſſo-pharyngeal nerves. It ſends out branches to unite with the gloſſo-pharyngeal, and which follow that nerve in its diſtribution to the tongue and pharynx. Many of its branches ſurrounding the carotid artery form connections with the internal and external laryngeal nerves, and proceed in meſhes, or form plexus along with the branches of the artery. Theſe may be followed to great minuteneſs.

To be more particular in the deſcription of theſe anterior branches of the ſympathetic nerve, they are called the NERVI MOLLES, or NERVI VASORUM. They are nerves peculiarly ſoft, with a greater proportion of cellular membrane; they ſpread in net-works along the arteries, and form frequent connections by little knots like ſmall ganglions. Claſſed with theſe nervi vaſorum, are branches which paſs forward from the upper ganglion of the ſympathetic, to unite with filaments from the internal laryngeal nerve of the par vagum, and which form the external laryngeal nerve.

It

It is remarked, that none of theſe branches of the ſympathetic nerve are diſtributed to the larynx and pharynx without being mingled and aſſociated with the gloſſo-pharyngeal nerve, or with the pharyngeal branch of the par vagum *. Of the nervi molles, ſome form a plexus upon the internal carotid artery. Theſe are extremely ſoft and pulpy, and are united with branches which deſcend from the gloſſo-pharyngeal nerve. A net-work is alſo formed, which covers the beginning of the external carotid artery. From this, as from a center, branches are ſent out with the arteries to the neck, and face, and glands under the jaw; and theſe laſt, with a meſh which paſſes up upon the temporal artery, unite with the portio dura of the ſeventh pair.

It has been often obſerved, that the branches of the carotid artery have a peculiar proviſion of nerves, and that theſe nerves are more numerous and minutely diſtributed than in any other part of the body. There are indeed no nerves in any part of the body which have ſo extenſive and intricate connections with important nerves as the cutaneous nerves of the face and neck. This diſtribution of the nerves is, I conceive, a proviſion for that power poſſeſſed by the imagination, or rather that uncontrolable connection which exiſts betwixt the feelings and the action of the veſſels in bluſhing.

The loweſt of the nervi vaſorum or molles, ſent off from the ſuperior ganglion of the ſympathetic nerve,

* Scarpa.

deſcends

descends in the course of the trunk of the nerve, and forms, with other branches, the superior cardiac.

This nerve, generally called NERVUS CORDIS SUPERFICIALIS, passing down in the direction of the trunk of the sympathetic nerve, and near the longus colli muscle, is for some length a very slender branch; but in its course it receives two, three, or four additional twigs from the sympathetic, and branches which come under the carotid artery from the pharyngeal nerves, or nervi molles. When this superior cardiac nerve is within an inch or two of the subclavian artery, branches of union pass betwixt it and the recurrent nerve of the par vagum; and branches of the nerves passing to the heart from the lower cervical ganglion, also join it. It then, attaching itself to the investing membranes and sheaths of the carotid and subclavian arteries, forms with others a plexus of nerves, which run along the great vessels to the heart.

The continued trunk of the sympathetic, where it emerges from the superior cervical ganglion, is extremely small. It descends behind the carotid artery, and lies near to the spine. When opposite to the fifth and sixth cervical vertebræ, the inferior cervical ganglion of the sympathetic is formed. In this course, twigs of communication pass betwixt it and the cervical nerves, or join it with the beginning of the phrenic nerve.

But not unfrequently there are three cervical ganglions formed by the sympathetic nerve; the superior, middle, and inferior ganglions: or it happens that we find the sympathetic nerve split into two branches in the

the neck; one of which forms the middle, and the other the lower ganglion.

There are received by the MIDDLE CERVICAL GANGLION, OR, THYROID GANGLION, branches of nerves from the third, fourth, fifth, and ſixth cervical nerves, and alſo ſometimes from the phrenic nerve. The ganglion is by no means conſtantly found, and it is irregular in its ſize and ſhape. When large, and in what may be conſidered as its more perfect ſtate, it gives off ſome conſiderable branches. Of theſe, part unite with the ſuperior cardiac nerve already mentioned; others form the great or deep cardiac nerve, while leſſer ones play round the ſubclavian artery, and unite with the lower cervical ganglion, or the upper thoracic ganglion.

The deeper cardiac branch of the ſympathetic, ſplitting and again uniting ſo as to form rings, runs outwards, attached to the arteria innominata and arch of the aorta, to the heart. In this courſe, while it paſſes before the trachea, it forms connections with the recurrent branch and trunk of the par vagum. Under the arch of the aorta, we find this branch concentrated to form the GANGLION CARDIACUM of Wriſberg, or GANGLION MOLLE and PELLUCIDUM of Scarpa. This ganglion is like a mere enlargement or ſwelling of the nerve. From this, four or five branches may be enumerated; 1ſt, A branch paſſing behind the pulmonary artery to the back of the heart, and following the left coronary artery; 2dly, A ſmall diviſion to the anterior pulmonary plexus of the par vagum; 3dly, A pretty conſiderable branch which, paſſing behind the aorta, and betwixt it and the pulmonary artery, is diſtributed

buted with the right coronary artery to the anterior part of the heart. On the left ſide of the neck, the ſympathetic, receiving on the one ſide branches from the cervical nerves, and on the other giving off branches, which deſcend behind the carotid artery to the heart, (viz. the ſuperior cardiac) often ſplits before it forms the middle or thyroid ganglion, and ſometimes throws its branches over the thyroid artery, and the ganglion lies upon that artery. Again, from the ganglion there deſcend two ſeries of numerous leſſer filaments, which form meſhes upon the thyroid and ſubclavian arteries to the heart. Others proceed downward behind the arteries to the lower cervical ganglion. Thoſe branches which deſcend upon the arteries, intangle the roots of the thyroid, tranſverſalis cervicis, and internal mammery arteries, in their plexus; theſe uniting, follow the ſubclavian artery, and form again a plexus upon the arch of the aorta. This is joined by branches from the par vagum and recurrent. The principal branches of this plexus terminate in the cardiac ganglion under the arch of the aorta *.

The LOWER CERVICAL GANGLION † of the ſympathetic nerve is placed upon the limits betwixt the neck and thorax upon the head of the firſt rib, and by the ſide of the muſculus longus colli; and it is in part covered by the root of the vertebral artery. The ganglion is of an irregular cuſhion-like ſhape. It lies cloſe

* This deſcription of the ſympathetic nerve on the left ſide follows the more uſual diſtribution, but is not peculiar to the left ſide.

† The lower cervical, or, *cardiac* ganglion of the ſympathetic nerve.

 to

to the cervical nerves which go to the brachial plexus, and it receives branches from them *. Branches alſo paſs from this ganglion to the par vagum and recurrent, and alſo paſs on to the cardiac and pulmonic plexus. That nerve, which muſt be conſidered as the continued ſympathetic, throws a ring round the root of the vertebral artery, and ſending out branches upon the ſubclavian, terminates in the firſt dorſal or thoracic ganglion.

THE SUPERIOR THORACIC GANGLION.

THIS ganglion ſurpaſſes the other thoracic ganglions in ſize. It is, indeed, frequently compoſed of many branches of the nerve in the neck, coming both before and behind the ſubclavian artery. It receives alſo nerves from the three or four loweſt cervical nerves, and firſt dorſal nerve. It is of a very irregular figure, or rather it varies exceedingly in its ſhape; ſo that by various anatomiſts it is deſcribed as round, oval, triangular, quadrangular, cylindrical!—Filaments proceed from this ganglion into the canal of the vertebral artery, and to the cellular coat of the ſubclavian artery, and to the cardiac plexus, and alſo to the pulmonic plexus; or to ſupply the poſterior ſurface of the lungs.

SYMPATHETIC NERVE IN THE THORAX.

THE ſympathetic nerve, (as we have explained in de-

* And even it receives ſometimes from the fifth and ſixth, more rarely the ſeventh and eighth, from the firſt and ſecond of the back; and laſtly, from the phrenic nerve.—Sometimes theſe connections are wanting.

ſcribing the dorſal nerves,) through all its courſe in the thorax, has additional branches from the dorſal or intercoſtal nerves. It forms alſo, while it is lying on the ſide of the vertebræ, a diviſion in the thorax, which it will be important to recollect. This nerve is ſent more forwards upon the body of the vertebræ, and paſſes into the abdomen betwixt the crura of the diaphragm; while the trunk of the ſympathetic continues its courſe by the heads of the ribs, paſſes under the ligamentum arcuatum, and downwards upon the lumbar vertebræ.

The SPLANCHNIC NERVE, then, is this anterior branch of the ſympathetic in the thorax. It is the great nerve of the viſcera of the abdomen. It generally has two or four roots from the trunk of the ſympathetic nerve, where it is oppoſite to the ſixth, ſeventh, and eighth intercoſtal nerves. It is ſeen lying under the pleura, and paſſing obliquely over the bodies of the lumbar vertebræ, from the ſeventh to the tenth. It then paſſes betwixt the crura of the diaphragm, enters the abdomen, and forms the great ſemilunar ganglion.

One or more branches are ſent forward from the ſympathetic, commonly from the ganglions, oppoſite to the interſtice betwixt the ninth and tenth, or tenth and eleventh ribs. Theſe alſo paſs the diaphragm, and unite with the ſemilunar ganglion. There is, however, a conſiderable variety to be obſerved both in the origines of the ſplanchnic nerve, and in the number of theſe ſubſidiary branches. A larger branch, going off betwixt the tenth and eleventh ribs, is ſo common, that it has the name of SPLANCHNICUS MINOR, or,

ACÇESSORIUS.

ACCESSORIUS. This nerve as frequently terminates in the renal plexus, as in the ſemilunar ganglion; or ſometimes it ſends branches to both.

CÆLIAC GANGLION AND PLEXUS.

THE ganglion which is called the ſemilunar ganglion, has no regular ſhape—and leaſt of all when it is fully diſſected. It is formed by the ſplanchnic nerve, and by branches which come from the lumbar nerves. It lies by the ſide of the cæliac artery, and conſiſts of many leſſer ganglions, (ſometimes to the number of eleven or twelve,) matted together into a glandular-like ſhape.

The ſemilunar ganglions of the ſplanchnic nerves lying on each ſide of the root of the cæliac artery, their connection with each other is frequent and intricate; ſo that they throw a meſh of nerves round the root and branches of this artery, which is the great ſource of veſſels to the ſtomach, liver, and ſpleen.—This plexus, formed by the ſemilunar ganglions round the cæliac artery, is the ſolar or cæliac plexus.

CÆLIAC PLEXUS.

THE cæliac plexus is the great ſource of nerves to the higher viſcera of the abdomen. The ſplanchnic nerves are the great, but not the only nerves which form this plexus. The par vagum ſends branches down from the ſtomach which join it; and even the phrenic nerve, which is the nerve of the diaphragm, ſends down twigs to unite to the branches of the ſplanchnic and par vagum. We ſhall find alſo ſmall

nerves which come from the feat of the kidney, and which are derived from the fuperior lumbar nerves.—These pafs acrofs the crura of the diaphragm, and enter into the cæliac plexus.—In purfuing the nerves of the vifcera further, we have it no longer in our power to follow individual branches, but have rather to mark the courfe, and enumerate the various fources of the plexus, and net-work of nerves which follow the great veffels.

From the cæliac plexus, there pafs out, 1. Nerves which accompany the phrenic arteries upon the lower furface of the diaphragm. 2. Nerves to the liver :—and of thefe there are two plexus, the right and left hepatic plexus ; one paffes along the vena portæ, biliary ducts, and right hepatic artery, to the right fide of the liver, the gall bladder and ducts ; this of courfe is the RIGHT HEPATIC PLEXUS : the LEFT HEPATIC PLEXUS paffes along the left hepatic artery ; and this has connection with the cardiac nerves, branches of the par vagum. 3. That plexus, which runs upon the leffer curve of the ftomach, while it is formed in a great meafure by the par vagum, has alfo connection with the folar or cæliac plexus. 4. The plexus of nerves which pafs to the lower orifice of the ftomach and duodenum is chiefly a divifion of the right hepatic plexus. Thefe nerves, to the liver, ftomach, and duodenum, are attached to the branches of the cæliac artery. Along the great fplenic artery, which is alfo derived from the cæliac artery, there paffes out a plexus of nerves to the fpleen. From this fplenic plexus there pafs nerves to the great omentum ; and they even unite with thofe paffing out upon the duodenum, and

and which attach themſelves to the right epyploic artery, and take a courſe upon the great curvature of the ſtomach.

Thus the ſolar or cæliac plexus is a great central net-work of nerves, which paſs out in diviſions to the liver, ſpleen, pancreas, ſtomach, duodenum, and omentum.

SUPERIOR MESENTERIC PLEXUS.

The place and connections of the ſuperior meſenteric plexus is at once known, when it is conſidered that it is formed upon the root of the ſuperior meſenteric artery.—It is formed by the cæliac plexus being continued down upon the aorta ſo as to involve the root of the meſenteric artery, and by nerves coming over the ſide of the vertebræ of the loins from the lumbar nerves. This plexus ſpreads betwixt the lamina of the meſentery, and extends upon the branches of the artery, and of courſe is diſtributed to the ſmall inteſtines and part of the colon. It conſequently ſupplies the meſenteric glands, and ſends nerves alſo to the pancreas, that join thoſe which it receives from the ſplenic plexus.

INFERIOR MESENTERIC PLEXUS.

The ſame meſh of nerves, being continued down upon the face of the aorta, ſurround the lower meſenteric artery, and follow its branches. This is the lower meſenteric plexus, or meſocolic plexus; and it is formed in a great meaſure from the branches of the continued trunk of the ſympathetic nerve.—As this plexus ſpreads upon the branches of the lower meſen-

teric artery, it paſſes to the left ſide of the inteſtinum colon and rectum—while the lower meſenteric plexus is continued from the upper one. On the ſide of the lumbar vertebræ it is continuous with the renal and ſpermatic plexus; and towards the pelvis, with the hypogaſtric plexus.

Before conſidering the other leſſer plexus of nerves in the abdomen, it is neceſſary to follow the continued trunk of the ſympathetic nerve which we had deſcribed as following cloſely the lateral part of the dorſal and lumbar vertebræ, whilſt the ſplanchnic nerves paſs obliquely over them to the viſcera of the upper part of the belly.

The CONTINUED TRUNK of the SYMPATHETIC NERVE, after it has given off the ſplanchnic nerve in the thorax, ſends ſeveral ſmall nerves forward over the vertebræ to the mediaſtinum and ſheath of the aorta. It then paſſes the diaphragm, keeping cloſe to the tranſverſe proceſs of the vertebræ. When, however, it comes lower upon the lumbar vertebræ, it lies more upon the ſide of their bodies, and the connections with the lumbar nerves are by ſmall and numerous twigs which ſtretch over the ſide of the vertebræ. In this courſe, it is giving off upon the fore part numerous irregular twigs to the ſeveral plexus. Where it lies under the veſſels which paſs to the kidney, it ſends up ſome branches to the renal plexus.

The renal plexus, however, is not entirely formed of theſe branches of the continued ſympathetic, but is rather a continuation from the cæliac and ſuperior meſenteric plexus; while the leſſer ſplanchnic nerve, which was ſent off in the thorax, alſo terminates in

it.

it. This plexus is thrown over the veſſels of the kidney, and forms ſeveral little ganglions.

From the renal plexus deſcends the SPERMATIC PLEXUS. This plexus of nerves in woman follows the ſpermatic artery in its diſtribution to the ovaria and uterus.

In paſſing down upon the loins, the ſympathetic nerve forms five or ſix ganglions with the branches from the lumbar nerves. Theſe are oblong, angular, ſtellated—irregular in their form, as in their number, ſituation, ſize, or the twigs which, in their union with the ſympathetic, form them. Betwixt theſe ganglions or connections with the lumbar nerves, the ſympathetic is not always one nerve, but is ſometimes ſplit into ſeveral ſmaller nerves, which unite again. From the ſympathetic nerves of either ſide we have to obſerve frequent interchange of branches, which ſometimes attach themſelves to the lumbar nerves, ſometimes creep under the aorta, or unite to the plexus covering the face of the aorta.—There are ſeveral little ganglions formed by theſe nerves upon the face of the lumbar vertebræ: they have the name of ganglia acceſſoria.

Before the ſympathetic nerve deſcends into the pelvis, it has become extremely delicate. In many ſubjects it ſeems to terminate in the laſt lumbar, or firſt ſacral nerve; but, upon more minute diſſection, leſſer branches will be found to deſcend amongſt the looſe cellular ſubſtance of the pelvis.—When regular, or perhaps we may ſay with truth when regularly and fully diſſected, the ſympathetic nerves of each ſide are ſeen to deſcend upon the fore part of the ſacrum, and

form connections with the facral nerves fimilar to thofe with the dorfal nerves.—As they defcend, they of courfe approach, and finally unite in an acute point on the os coxigis.—At the points of union of thefe extreme branches of the fympathetic nerves with the branches of the facral nerves, fmall ganglions are formed; and there pafs out branches from them, which cover the intermediate furface of the facrum with an extenfive plexus. The ultimate ganglion, formed by the union of the two fympathetic nerves, is the *coxygeal ganglion*, and from it there pafs three or four nerves to the extremity of the rectum.

HYPOGASTRIC PLEXUS.

THIS is a plexus which lies on the fide of the pelvis, and involves the hypogaftric artery. It confifts of the nerves paffing to the parts contained in the pelvis; which do not, however, pafs in diftinct branches, but, like thofe of the abdomen, are formed into minute interwoven net-work. The hypogaftric plexus takes no determinate origine, but is continuous with, or formed by, the extreme branches of the fympathetic nerves, the extremity of the fpermatic plexus, the facral nerves, (and particularly the third facral nerve,) and by the branches of the acceffory ganglions on the facrum.

OF THE PHRENIC NERVE.

THE phrenic or diaphragmatic nerve arifes from the cervical nerves, paffes obliquely down the neck, enters the thorax, and is diftributed to the diaphragm.—This nerve has much variety in its derivation. It comes chiefly

chiefly from the third cervical nerve, deriving alſo ſome twigs from the fourth and ſecond. But ſometimes it takes an origine very high in the neck, from the par vagum or ninth nerve; and even the ſuperior cervical ganglion of the ſympathetic is deſcribed by ſome as furniſhing a root.—Lower in the neck it will be found in ſome ſubjects to derive very ſmall additional twigs from the fifth or ſixth cervical nerves, or lower ganglion of the ſympathetic.

The phrenic nerve, thus formed, deſcends into the thorax betwixt the ſubclavian artery and vein. In the cheſt it proceeds downward and forward, attached to the mediaſtinum, and before the root of the lungs *. It takes its courſe upon the outſide of the pericardium, and from the pericardium ſlips off to the ſurface of the diaphragm. From the poſition of the heart, the left phrenic nerve differs a little in its courſe from the right; and it paſſes over the pericardium, covering the apex of the heart. The phrenic nerve of the right ſide,

* Ludwig. Martin, in the Edinburgh Eſſays, and others, explain the action of the diaphragm upon the ſuppoſition of the mechanical preſſure of the lungs upon the phrenic nerve. It is a piece of doctrine inconſiſtent with knowledge of the general laws of the œconomy. It is repugnant to comparative anatomy, and it is evident that the ſoft and elaſtic diſtention of the lungs could not compreſs the firm nerve. Moreover, the lungs when diſtended do not preſs upon the mediaſtinum, for it is the dilation of the thorax which cauſes the lungs to inhale the atmoſpheric air. See *Wriſberg de Nervo Phrenico*. Sandiſt. Theſ. vol. ii. p. 260. It is betwixt the heart and muſcles of reſpiration that the ſtrict relation and ſympathy exiſts. When in turning the child in utero, and when the cord has been preſſed, I have felt the ſtrong convulſive *fetches* of the muſcles of reſpiration endeavouring, by the play of the lungs, to compenſate for the loſs of the placenta.

beſides

besides supplying the diaphragm, sends down through the diaphragm (to the right side of the vena cava) the ramus anastamoticus. This communicates with the semilunar ganglion of the sympathetic, or with the division of the solar or cæliac plexus which passes along the phrenic arteries. From the phrenic artery of the left side, there pass down with the œsophagus small nerves which, appearing in the abdomen, unite with the cæliac ganglion, or some of its divisions; and both phrenic nerves will be found by some minute branches to unite to the par vagum.

These, however, are but minute branches. The great destination of the phrenic nerve is to the diaphragm. The branches strike out from the diaphragm like roots from a centre; they pass some way only covered by the pleura, and then pierce into the substance of the muscle. There are innumerable experiments upon living animals, which shew the connection of this nerve with the action of the diaphragm. When the nerve is stimulated, the diaphragm is excited to contraction; when cut, pressed, or tied, it becomes relaxed and inactive, and there is difficulty of respiration; when the spinal marrow is injured low in the vertebræ of the neck, or in the vertebræ of the back, the external muscles of respiration cease to act, but the diaphragm still continues its function; and in this case, as observed by Mr. Hunter, the patient lives for some days, breathing by the diaphragm. If the phrenic nerves be divided in a living animal, the diaphragm ceases to act, and the abdominal muscles lose their opponent muscles, and remain as in expiration; but still the respiration is continued by the motion of the ribs.

If,

If after this the ſpine be divided, the motion of the lungs ceaſes entirely, and the animal dies ſuddenly.— The injury of the ſpinal marrow above the origine of the phrenic nerves, is of courſe ſuddenly fatal, becauſe it deſtroys at once the function of the diaphragm, and muſcles moving the cheſt. From the connection of the phrenic nerve with the par vagum, we may explain the ſympathy betwixt the trachea and the diaphragm, how the irritation of the trachea occaſions coughing and the convulſive action of the diaphragm; in the ſame manner in the affection of the ſtomach, ſingultus, from the ſudden action of the diaphragm and abdominal muſcles, (which uſually alternate in their action,) may be explained. Again, a connection of nerves might be followed from the origines of the phrenic to the ſympathetic nerve, and branches of the fifth pair to the noſe; which accounts for that ſympathy of action which occaſions ſneezing from irritation of the membrane of the noſe.

NERVES OF THE ARM; AXILLARY, OR BRACHIAL PLEXUS.

THE nerves which proceed from the ſpine, and go to ſupply the arm, are formed into an intricate plexus before they divide into the ſeveral nerves of the arm.

This brachial, or axillary plexus, is formed of five of the ſpinal nerves; viz. the fifth, ſixth, ſeventh, and eighth cervical nerves *, and the firſt dorſal nerve.

* This is of courſe counting the ſuboccipital as the firſt cervical nerve.

The

The higheſt of theſe nerves proceed from betwixt the fourth and fifth cervical vertebræ; the laſt from betwixt the firſt and ſecond dorſal vertebræ. They paſs out betwixt the middle and anterior diviſion of the ſcaleni; and even while covered by theſe muſcles, and before they have proceeded far from their foramina, the laſt nerve of the neck and firſt of the back unite *.—The plexus is continued from above the clavicle to the edge of the tendon of the latiſſimus dorſi. It allows of no natural diviſion. The axillary nerve paſſes for ſome way cloſe under it, and then perforates betwixt the diviſions which form the radial nerve.

From the axillary plexus proceed theſe nerves:

1. The thoracic nerves.
2. The ſupra and infra ſcapular nerves.
3. The circumflex, or articular nerve.
4. The perforans caſſerii, or external cutaneous nerve.
5. The radial nerve.
6. The ulnar nerve.
7. The muſcular ſpiral nerve.
8. The internal cutaneous nerves.

1. The THORACIC NERVES. Although the nerves which ſupply the muſcles of the cheſt are derived from the intercoſtal nerves, as we have ſeen, yet there alſo

* Before the nerves which form the plexus intermix their filaments, or are connected together, they ſend off ſmall branches to the ſcaleric muſcles, to the muſcles of the ſpine, and to the levator ſcapulæ.—The branches which they give to the ſympathetic nerve, we have already noticed.

paſs

paſs off branches from the axillary plexus to the great and little pectoral muſcles, to the latiſſimus dorſi, to the ſkin and mamma. Theſe thoracic branches proceed from the upper diviſion of the plexus, or that which gives out the external cutaneous, and one of the roots of the radial nerve.

2. The SUPRASCAPULAR NERVE comes off from the upper edge of the plexus, and is the higheſt of the branches. It runs towards the root of the coracoid proceſs, it paſſes through the notch of the ſcapula, and goes to ſupply the ſupra and infra ſpinatus muſcles, the teres minor, and the ſubſcapularis.

The SUBSCAPULAR NERVES come out from the poſterior part of the plexus along with the articular nerve. They are attached to the ſubſcapular muſcle, they turn round the fleſhy edge of the muſcle, and inſinuate their branches betwixt the tendon of the latiſſimus dorſi and the teres major.

3. The CIRCUMFLEX, or ARTICULAR NERVE, or AXILLARIS, lies very deep. It comes from the back part of the plexus, paſſes behind the neck of the humerus, and above the tendon of the latiſſimus dorſi, and teres major. One of its branches we trace into the teres major, while another paſſes round the bone, and is diſtributed to the under ſurface of the deltoid muſcle, the joint, and the cellular membrane.

4. PERFORANS CASSERII, or the EXTERNAL CUTANEOUS NERVE. This nerve paſſes through the coraco-brachialis muſcle before the os humeri, to gain the outſide of the arm. From its perforating this muſcle, and being deſcribed by Caſſerius, it is called the nervus perforans Caſſerii. Before paſſing through

the coraco-brachialis muſcle, it ſends down a branch of communication with the radial nerve; and in many ſubjects it will be found to be like a branch from one of the origines of the radial nerve. Where the nervus perforans lies betwixt the brachieus internus muſcle and biceps, (and, of courſe, after it has perforated the coraco-brachialis muſcle), a branch or two are ſent up to the heads of the biceps muſcle; another branch turns inward to the belly of that muſcle; and, finally, twigs paſs inward to the cellular membrane, which involves the brachial artery.

The continued nerve paſſes obliquely acroſs the arm, and under the biceps. When approaching the outſide of the arm, it divides into three ſmall branches; one to the integuments which are upon the ſupinator longus, another to the integuments on the inſide of the fore-arm, and a third, which continues its courſe along the edge of the ſupinator longus to the wriſt. Of this prolonged branch of the perforans Caſſerii, a minute twig is loſt on the ligament of the wriſt, another paſſes to the ball of the thumb, and a third goes round to the integuments of the back of the thumb.

5. The RADIAL NERVE. This nerve is formed by thoſe diviſions of the plexus which ſurround the brachial artery, and ſometimes by a diviſion of the perforans Caſſerii. It takes its courſe by the ſide of the brachial artery, and gives off no branches until it has ſunk under the apponeurotic expanſion of the biceps muſcle.

When the radial nerve has come to the bend of the arm, it gives off three branches. The firſt belongs to the pronator teres, flexor radialis, and palmaris longus, and

and flexor digitorum; a ſecond paſſes to the pronator teres; and a third to the deep muſcles of the fore-arm, and to the flexors of the thumb particularly, and alſo to the pronator quadratus muſcle. The radial nerve, continuing its courſe down the fore-arm betwixt the flexor ſublimis and profundus digitorum, ſends off other branches to thoſe muſcles. Before paſſing under the ligament of the wriſt, it gives out a branch which emerges from the tendons, and paſſes to the integuments, ſhort flexor, and abductor muſcles of the thumb.

The trunk of the radial nerve paſſes with the tendons of the flexor muſcles of the fingers under the ligament of the wriſt. In the palm of the hand it divides into five branches;—the firſt paſſes to the abductor and flexor pollicis brevis; a ſecond goes to the adductor policis, and ſide of the thumb next the fore-finger; the third paſſes to the fore-finger, and to the lumbricalis muſcle; the fourth to the ſide of the fore and middle fingers; and the fifth to the ſides of the middle and little finger. All theſe nerves, while in the palm of the hand, ſend off branches to the lumbricales muſcles.

6. The ULNAR NERVE comes off from the lower part of the plexus in union with the internal cutaneous nerve. It deſcends upon the inſide of the arm, and is tied down by the faſcia, and then paſſes behind the internal condyle of the humerus. While above the bend of the arm, it gives off a ſuperficial branch to the integuments on the inſide of the arm, and the ulnar ſide of the fore-arm; at the ſame time it ſends a muſcular

branch through the triceps muſcle, along with the arteria profunda inferior. Immediately above the elbow joint, twigs are ſent off, ſome of which accompany the ramus anaſtamoticus major of the brachial artery. After paſſing the condyle of the humerus, it ſends a branch to the flexor carpi ulnaris, and to the head of the flexor digitorum profundus. It then ſinks deeper betwixt the flexor ulnaris and flexor digitorum ſublimis; it is here connected with the ulnar artery, and deſcends along with it to the wriſt. In this courſe, along the fore-arm, the ulnar nerve gives branches to the flexor digitorum ſublimis. Often it ſends a branch of communication to the radial nerve, while ſome few leſſer muſcular nerves are ſent off, and accompany the branches of the ulnar artery.

When arrived near the wriſt, the ulnar nerve divides into two branches. The continued trunk paſſes on under the protection of the tendon of the flexor ulnaris, and then under the arcular ligament into the palm of the hand; while the branch takes a turn under the flexor ulnaris, and over the edge of the flexor digitorum profundus. It paſſes then over the lower end of the ulna to the back of the hand. On the back of the hand it is found branching over the expanded tendons and under the veins, and is finally diſtributed to the back of the little and ring fingers. This is the *ramus poſticus*.

The continued ulnar nerve paſſes under the palmaris brevis muſcle and palmar apponeuroſis, and above the flexor brevis and adductor minimi digiti. Here it divides into two, (the ſublimis and profundus of Camper,) and

and theſe again into four principal branches—to the integuments on the ulnar edge of the hand, and adductor minimi digiti—to the outer edge of the little finger,—to the ſide of the little and ring fingers, and a branch which communicates with the radial nerve.

Albinus, Monro and Camper differ in regard to the diſtribution of nerves to the lumbricales muſcles, which only proves that the twigs paſſing to thoſe little muſcles are irregular. They come chiefly from the deep branch of the ulnar nerve, whilſt others are from the radial nerve.

7. The MUSCULAR SPIRAL NERVE. We find the external cutaneous nerve, or perforans caſſerii, paſſing before the arm-bone. The muſcular ſpiral nerve paſſes behind the bone, and takes a ſpiral turn under it to get to the outſide of the arm. It perforates the fleſh of the arm betwixt the middle and the ſhort head of the triceps muſcle. Before it perforates the triceps muſcle, the muſcular ſpiral ſends off branches which paſs over the tendon of the latiſſimus dorſi; and before it enters the triceps muſcle, it may be obſerved to divide into ſeveral branches. Three of theſe may be mentioned: a branch to the middle head, and one to the ſhort head of the triceps muſcle, and a third and larger nerve which pierces betwixt the muſcles, along with the trunk of the nerve.

This laſt nerve does not follow the trunk of the nerve in its courſe, but perforating the triceps more directly acroſs, it comes out behind the ſupinator longus, where it takes its origin from the os humeri.

This is a cutaneous branch, and might be confidered as the external cutaneous nerve with as much propriety as the perforans cafferii. Often we fhall find fome leffer branches of the mufcular fpiral nerve piercing the fibres of the triceps mufcle, and terminating in the fkin.

The great cutaneous divifion of the nerve, after piercing the triceps mufcle, takes its courfe along the integuments covering the fupinator longus mufcle; and here it fends a branch in upon the bend of the arm, and on the edge of the triceps mufcle. It then defcends upon the outfide of the fore-arm, and divides into three principal branches, and then again into innumerable cutaneous twigs, and is continued down over the back of the thumb and hand.

But the great divifion of the mufcular-fpiral nerve comes out betwixt the head of the fupinator longus mufcle and the bone, and is deep feated. This branch then lies betwixt the fupinator longus, and brachæus internus; and here it gives off feveral fmall twigs to the mufcles. Continuing its courfe by the fide of the fupinator longus and flexor radialis, it divides into a deep and fuperficial branch. The fuperficial branch paffes down on the fide of the tendon of the fupinator longus, and near the wrift it becomes quite fuperficial, and is diftributed to the integuments of the back of the hand.

8. The INTERNAL CUTANEOUS NERVES. Of thofe we may defcribe three:—

1. The *great internal cutaneous nerve*. This nerve is derived from the ulnaris at its root, or comes off from

from the plexus along with it, paſſes down the arm, giving off no conſiderable branches, accompanies the baſilic vein and twiſts its branches over it, divides into four branches upon the faſcia of the fore-arm, and running betwixt the faſcia and veins of the fore-arm, it is finally diſtributed to the cellular membrane and integuments, while one of its branches reaches to the ligaments of the wriſt.

2. The *cutaneous nerve of Wriſberg* comes ſometimes from the axillary plexus, as a diſtinct nerve; ſometimes it is a branch of the great internal cutaneous nerve; ſometimes it is derived, or a nerve which takes its place is derived from the intercoſtal nerves. This nerve of Wriſberg is diſtributed to the integuments of the arm, and terminates near the internal condyle.

3. The *upper and internal cutaneous nerve* comes from the firſt intercoſtal nerve, or from the ſecond, and paſſes out betwixt the firſt and ſecond ribs. It ſupplies the integuments of the arm, and the glands and fat of the axilla *.

There are beſides ſeveral nerves derived from the intercoſtal nerves, which croſs the axilla, and ſupply the arm-pit and ſide.

NERVES OF THE THIGH, LEG, AND FOOT.

In tracing the nerves of the lower extremity, we find no difficulty in the arrangement at leaſt, for they fall into a very ſimple and natural order. They are all derived from the lumbar and ſacral nerves. The

* See Syſtem of Diſſections, vol. ii. plate 1. g.

great nerves are three in number. One paſſes out under Paupart's ligament to the extenſor muſcles of the leg, *viz.* thoſe which lie on the fore-part of the thigh. This of courſe is called the anterior crural nerve. The ſecond nerve is the obturator nerve, ſo called becauſe it paſſes out from the pelvis by the thyroid hole. This nerve lies amongſt the deep muſcles of the thigh, and diſtributes its branches chiefly to the adductor muſcles. The third nerve is the greateſt nerve of the body, *viz.* the iſchiatic nerve. It paſſes out from the back part of the pelvis, through the ſacro-ſciatic notch, and takes its courſe down the back of the thigh into the ham. In this courſe it ſupplies the muſcles lying on the back of the thigh, but its chief deſtination is to the leg and foot.

OF THE CUTANEOUS NERVES OF THE THIGH.

It will be found conſiderably to take from the intricacy of the minute anatomy of the nerves of the lower extremity, to diſpoſe firſt of theſe nerves which lie under the integuments of the thigh.

Theſe cutaneous nerves of the thigh come from the lumbar nerves, or more immediately from the anterior crural nerve. They pierce the tendon of the oblique muſcle of the abdomen, or paſs under Paupart's ligament, and are diſtributed to the groin, ſcrotum, and betwixt the faſcia and integuments of the fore-part of the thigh. There may be deſcribed five cutaneous nerves on the fore-part of the thigh, *viz.* the *external cutaneous*, the *middle cutaneous*, the *anterior cutaneous*, the *internal cutaneous*, and thoſe of the groin and ſcrotum.

The

The EXTERNAL CUTANEOUS NERVE is that which comes out from the belly near the ſuperior ſpinous proceſs of the ilium. It divides almoſt immediately into two great branches, and in the front view of the thigh the anterior branch alone is to be ſeen. It takes a courſe above the faſcia in the direction of the line which divides the vaſtus externus from the rectus femoris, and terminates near the knee, while the poſterior branch paſſes over the tenſor vaginæ femoris, and down upon the outſide and back of the thigh. It is derived from the third lumbar nerve.

The MIDDLE CUTANEOUS NERVE riſes from amongſt the integuments of the groin, and emerges from under the faſcia near the upper edge of the ſartorius muſcle. It paſſes down upon the rectus muſcle, and is diſtributed to the integuments in three or four diviſions.

The ANTERIOR CUTANEOUS NERVE comes out to the integuments very high up, and in the middle of the groin betwixt the pubes and tuberoſity of the os ilii. It paſſes down the thigh along the ſurfaces of the ſartorius and vaſtus internus muſcles. This, like all the other cutaneous nerves, runs along above the faſcia, and on the lower ſurface of the ſkin.

The INTERNAL CUTANEOUS NERVE is the leaſt regular. It does not pierce the faſcia in one trunk, but ſends three, four, or five branches through the faſcia, which are diſtributed to the integuments on the inſide of the thigh. Some of theſe, after running a conſiderable way under the faſcia, emerge and encircle the inſide of the knee.

Beſides theſe more remarkable cutaneous nerves, there come down ſmall nerves to the groin and ſcro-

 tum.

tum. The firſt lumbar nerve ſends down the external ſpermatic nerve. This joining the ſpermatic plexus, helps to ſupply the cord and teſticle; and in women the ſame nerve goes to the womb within the pelvis, and following the round ligament, terminates on the fat of the pubes and groin. A branch from the ſecond lumbar nerve paſſes alſo to the glands and fat of the groin, the pubes, and cremaſter muſcle. This branch is remarkable for the circuitous courſe it takes round the ilium and inſide of the ligament of the thigh.

ANTERIOR CRURAL NERVE *.

THIS nerve ariſes from the union of the ſecond, third, and fourth of the lumbar nerves, or the ſecond and third lumbar nerves uniting into one trunk, are afterwards joined by a diviſion of the fourth †, or the anterior crural, is formed by the anterior branch of the third and the firſt branch of the ſecond lumbar nerve ‡, or by the four firſt lumbar nerves; and the anterior crural nerve, at its origin, lies under the pſoas magnus, and, as it deſcends, it holds its courſe between the pſoas magnus and iliacus internus. It then deſcends towards the thigh, and paſſes out under Paupart's ligament; and in its courſe along the brim of the pelvis, it is for ſome way covered by the external iliac artery. Here, while within the pelvis, it gives off ſeveral ſmall nerves, which paſs into the iliacus internus, and under the pſoas magnus muſcles. Theſe form a kind of ſmall plexus.

* *Crural nerve, truncus lumborum, femoralis magnus.*

† Fiſcher—Walter. ‡ Sabatier and Haller.

As

As the anterior crural nerve paſſes under Paupart's ligament, it ſplits into its numerous branches which ſupply the muſcles and integuments on the fore part of the thigh. From the fore part of the nerve there is ſent out a muſculo-cutaneous branch, which, while it deſcends and ſupplies ſeveral of the muſcles of the thigh, gives out the middle cutaneous nerve. The anterior cutaneous nerve is ſent off lower down, but almoſt immediately after it has paſſed under Paupart's ligament. The internal cutaneous nerve is ſent off from ſome of thoſe branches which run under the internal articular artery.

The laſt of the cutaneous branches of the anterior crural nerve, and the moſt important, is the NERVUS SAPHENUS, or CUTANEUS LONGUS. This is the chief cutaneous nerve of the leg; but it is to be diſtinguiſhed as a particular nerve, ſo high as under the external articular or circumflex artery, being a diviſion of what is called the NERVUS LONGUS. This nerve is ſometimes joined by a branch of the obturator nerve; and the muſcular branches which it gives off, paſs into the vaſtus internus.

When we are diſſecting in the courſe of the femoral artery, we have to obſerve two nerves running parallel to, and connected with the ſheath of the artery. That which is on the inſide is the largeſt, the courſe of which we ſhall proſecute. It follows the artery through the tendon of the triceps muſcle, but it does not deſcend into the ham with the popliteal artery. It comes out again through the tendon with the perforating branches of the popliteal artery, or with the upper and internal articular artery. It then becomes a ſuperficial nerve, and

and deſcends upon the inſide of the leg with the ſaphena vein, to the inner ancle and foot.

Thoſe two nerves, which are ſo cloſely connected with the femoral artery in the middle of the thigh, are very often taken up with the extremity of the artery in amputation. This occaſions twitching in the ſtump and a fetid diſcharge.

Where the continued nerve deſcends upon the inſide of the leg, it ſends out many twigs to the integuments, and is entangled with the ſaphena vein. Here it has been pricked in bleeding in the ancle.—Sabatier gives us an inſtance of this. The patient had been previouſly ſubject to nervous affections. She felt in the inſtant of the operation an acute pain, which was ſucceeded by convulſive motions, firſt of the limb and then of the whole body. Theſe attacks returned from time to time, ſhe loſt her health, and for many years was ſtill in ſuffering almoſt continual.—He relates to us another inſtance of the injury of this nerve accompanying the ſaphena vein, in the caſe of a young man who received a wound with the ſmall ſword in the inſide of the knee. There came on much fever and ſwelling of the part, with great pain of the limb. This ſubſiding, there followed ſlight trembling of the limb, which gradually increaſed to an extreme degree. The cauſtic was propoſed, but the patient had not reſolution to let it be applied. After long ſuffering with exhauſted ſtrength, he was at laſt relieved by nature, and his health gradually returned.

Theſe branches we have mentioned are only the cutaneous or ſuperficial branches of the anterior crural. The larger and more numerous ſet of branches are

thoſe

thofe to the mufcles lying on the fore-part of the thigh. Thefe diverge fuddenly into innumerable twigs, and are entangled with the branches of the arteries, and follow them in their diftribution. There can be no excufe for beftowing particular names on thefe branches;—to fay that one is the branch to the pectinalis, another the branch to the fartorius, another to the rectus, &c. is fufficient.

OBTURATOR NERVE.

THIS nerve arifes by fafciculi from the fecond and third lumbar nerves, and fometimes by a fmall twig from the fourth. It is formed, however, chiefly by the third lumbar nerve. It then lies under the internal border of the pfoas magnus. It defcends into the pelvis, and goes obliquely downwards to pafs through the ligamentous membrane which fills up the thyroid hole. The obturator nerve, before it efcapes from the pelvis, fends off a branch which, accompanying the parent nerve, is given to the external obturator mufcle. When it has efcaped from the pelvis, this nerve lies before the heads of the triceps, and behind the pectinalis mufcle; and it here divides into two branches in the very middle and internal flefh of the thigh. The anterior of thefe branches paffes down betwixt the adductor mufcles, or heads of the triceps, fupplies thofe mufcles and the gracilis, and fends a branch of communication with the faphenus nerve. The pofterior divifion goes down betwixt the adductor magnus and brevis, fends branches to the obturator externus and adductor brevis, and continues its courfe downward before the great flefhy partition of the adductor mufcles, and

and parallel with the crural veſſels, to the fat above the inner condyle of the femur.

THE ORIGIN OF THE ISCHIATIC NERVE.

THE iſchiatic nerve is formed by the two laſt nerves of the loins, and the three firſt of the ſacrum: or we may deſcribe its origin more particularly thus; the anterior branch of the fourth lumbar nerve and the trunk of the fifth uniting, form a ſtrong cord of about two inches in length; this root is joined to another nearly as large, formed by the firſt and ſecond ſacral nerves; and again, a third diviſion joins it from the inferior branch of the ſecond ſacral nerve and from the third *. The iſchiatic nerve is thus formed of three great roots matted together into a kind of plexus, and then paſſes betwixt the pyriformis muſcle and the gemini, and thus eſcapes from the back part of the pelvis by the great iſchiatic notch.

But before following this great nerve into the thigh, we muſt take notice of many leſſer nerves ſent out from the ſacral nerves, and from the trunk of the iſchiatic nerve. Theſe nerves paſs to the muſcles and integuments of the nates and back of the thigh to the perineum and private parts.

OF THE LESSER NERVES WHICH GO OUT FROM THE BACK PART OF THE PELVIS.

1ſt. THERE paſs off branches from the ſecond and

* This third and loweſt origin, before uniting with the others to form the iſchiatic nerve, gives out many ſmall branches to the hypogaſtric plexus and viſcera of the pelvis, to the perineum and private parts.

third lumbar nerves, which form a muſcular nerve of conſiderable ſize. This muſcular nerve paſſes down upon the inſide of the pelvis, eſcapes from the back part of the pelvis, and is diſtributed to the gluteus medius, the gluteus minimus, and the tenſor vaginæ femoris.

2d. There paſs off one or two very ſmall nerves from the body of the iſchiatic nerve, while yet within the pelvis, or from the middle diviſions of its origins, which go to the pyriformis and gluteus medius muſcles.

3d. Juſt where the great nerve paſſes over the poſterior ligaments of the pelvis, there goes off a twig to the obturator externus gemini and quadratus femoris. While theſe nerves are ſent off upon the anterior face of the nerve, there goes backward a large faſciculus of nerves to the glutei muſcles, and to the integuments of the nates *.

There proceeds a nerve ſomewhat more important than theſe from the third ſacral nerve, *viz.* the NERVUS PUDENDUS. This nerve paſſes out above the ſhort ſacro-iſchiatic ligament, and re-enters under the long ſacro-iſchiatic ligament. It then runs by the ſide of the ramus iſchii, and aſcends in the perineum and branches to the erector penis, accelerator urinæ, and tranſverſalis perenei, and paſſes on to the integuments and external parts of generation.

* Branches of that root of the iſchiatic nerve which is derived from the third ſacral nerve, go alſo out to the buttock; and ſome deſcribe a ſuperior, middle, and inferior cutaneous nerve of the nates.

OF

OF THE CUTANEOUS NERVES OF THE BACK OF THE THIGH.

WHEN the integuments are diffected off from the nates and back of the thigh, we fee two fources of the cutaneous nerves; firft from the lumbar nerves, which give out many fmall nerves which pafs over the fpine of the os ilii, and the branches of the anterior and outer cutaneous nerve; and fecondly, from under the lower margin of the great gluteus mufcle, there come many extenfive cutaneous nerves. Thefe are derived from the nervus cutaneus pofterior et fuperior, and branches of the ifchiatic nerve, in this manner;

Juft as the great ifchiatic nerve has efcaped from the pelvis, it is joined by the SUPERIOR and POSTERIOR CUTANEOUS NERVE; or, rather, a fmall twig is fent off from the great nerve to join this cutaneous nerve * on its emerging from the pelvis. It divides into feveral branches, and it is one of thefe which may be feen fuperficial and above the delicate fafcia, running down upon the outer ham-ftring mufcles, to the back of the knee-joint. Another branch piercing the fafcia feparately, comes down upon the integuments covering the outer and back part of the thigh, and terminates on the outfide of the knee. A little further down, the ifchiatic nerve gives off fmall nerves to the mufcles furrounding the hip joint; and, whilft the fciatic nerve is paffing over the quadratus femoris, the INFERIOR and

* The pofterior cutaneous nerve rifes in general from the trunk of the ifchiatic nerve, within the pelvis, and is joined by a branch from the third facral neive.—Ioerd. Haafe.

INTERNAL

INTERNAL CUTANEOUS NERVE is given off. This nerve runs down even to the inſide of the calf of the leg.—The EXTERNAL and POSTERIOR CUTANEOUS NERVE is a branch ſent off from the iſchiatic nerve, after it has deſcended from under the gluteus maximus, and juſt before its diviſion into two faſciculi, *viz.* the tibial and peroneal nerves. This external and poſterior cutaneous nerve paſſes down upon the integuments of the back part and outſide of the leg.

OF THE TRUNK OF THE ISCHIATIC NERVE IN THE THIGH.

BUT we muſt not allow theſe leſſer branches to diſtract our attention from the general courſe of the great nerve, which paſſes over the gemini muſcles, betwixt the tuberoſity of the iſchium and the trochanter major, then runs deep under the bellies of the hamſtring muſcles, and is lodged immediately in the great cavity behind the knee-joint, in company with the popliteal artery and vein. In this courſe the ſacro-ſciatic gives off branches to the quadratus femoris, the biceps cruris, ſemitendinoſus, and ſemimembranoſus and triceps.

A little below the middle of the thigh, the great iſchiatic nerve divides into the internal and greater, and the leſſer and external popliteal nerves. But as this is really the diviſion into the two great nerves of the leg, we take the more determinate names of tibial and fibular nerves.

TIBIAL NERVE.

THE greater and more internal of theſe diviſions of

the popliteal nerve, is the tibial nerve. Whilſt it is yet in the hollow behind the joint formed by the hamſtring tendons, it gives off a nerve which comes out from the ham, and deſcends ſuperficially on the back of the leg. This has been called RAMUS COMMUNICANS TIBIEI. When this nerve has arrived oppoſite to the beginning of the tendon achillis, it turns a little to the outer ſide, paſſing upon the outer margin of the achilles tendon, over the outer ſide of the heel-bone, and is finally diſtributed on the outſide and fore-part of the foot. Upon the back of the leg, this nerve unites with a branch deſcending from the fibular nerve, nearly in the ſame courſe, and with the ſame deſtination.

After giving off this ſuperficial branch, the tibial nerve ſends branches to the back of the knee-joint and popliteus muſcle, to the plantaris muſcle, and to both heads of the gaſtrocnemius. It then deſcends behind the articulation, and behind the head of the tibia. It then paſſes under the origins of the ſoleus, and betwixt the ſoleus and flexor longus digitorum pedis, and tibialis poſticus, and deſcends to the inner ancle. In this courſe it furniſhes many branches to the lower part of the popliteal muſcle, to the tibialis poſticus, to the flexor communis digitorum, and to the flexor policis longus, and many of theſe branches, and in cutaneous twigs. We have alſo to obſerve a particular branch which the tibial nerve detaches, which paſſes betwixt the heads of the tibia and fibula, and goes to ſupply the muſcles ariſing from the fore part of the interoſſeous ligament. Further down, two or more ſmall branches of the nerve alſo perforate the interoſſeous ligament,

ligament, to ſupply the muſcles lying on the outſide of the tibia. The tibial nerve, in its courſe amongſt thoſe poſterior muſcles, accompanies the poſterior tibial artery. When it has arrived behind the inner ancle, it ſends off a branch to the integuments of the inſide of the foot, and to the abductor muſcle of the great toe. Continuing its courſe by the ſide of the heel-bone and under the ligament, it begins to ſplit into thoſe branches which are naturally called the plantar nerves, becauſe of their lying in the ſole of the foot.

THE PLANTAR NERVES.

THE internal plantar nerve paſſes over the abductor muſcle of the great toe, and by the inſide of the ſhort flexor to the firſt metacarpal bone; and in this courſe it gives out ſeveral twigs to the muſcles of the ſole of the foot. It now divides into three branches. Theſe are diſtributed to the great toe, to the ſecond, the third, and one ſide of the fourth toes; and theſe nerves in their courſe give branches to the lumbricales and interoſſii muſcles.

The external plantar nerve is the leſſer of the two. It gives branches to the ſhort flexor and adductor of the little toe, and to the maſſa carnea Jacobi Silvii. It gives alſo a deep branch to the third and fourth interoſſeous muſcle and adductor muſcle of the great toe. Another of its branches makes the arch with the internal plantar nerve, while its extreme diſtribution is to the little toe, and to one ſide of the fourth toe. Theſe nerves of the ſole of the foot are connected with the internal and external plantar arteries, and are protected like them by the plantar apponeuroſis.

THE FIBULAR NERVE.

The fibular nerve is the more external divifion of the popliteal nerve. It feparates from the tibial branch about four inches above the knee-joint; it does not pafs down under the gaftrocnemius, like the tibial nerve, but turns towards the outfide of the joint, and paffes round the head of the fibula, and under the origin of the peroneus longus.—Before the fibular nerve paffes from behind the joint, it gives off feveral branches. There are fent down two branches to the integuments. One of thefe branches unites with the communicans tibiei, and defcends with it to the outer ancle. Sometimes this anaftamofis is formed high in the leg upon the heads of the gaftrocnemius. More generally there is a double communication formed by thefe nerves about the termination of the belly of the gaftrocnemius mufcle in the achilles tendon. This prolonged branch of the fibular nerve terminates upon the fide and upper part of the foot, and upon the little toe. There are alfo fome nerves fent off from the fibular, which are diftributed about the back and fides of the knee-joint.

When the fibular nerve has turned over the head of the fibula, it divides into two great branches. The deeper seated of these branches, though it is not the largeft of them, may be confidered as the continued trunk. It paffes deep amongft the mufcles, lying betwixt the tibia and fibula, and fupplies the tibialis anticus, the extenfor communis digitorum, extenfor longus policis, and the peroneus brevis. Thus the deeper divifion of the fibular nerve, taking its courfe

course between the tibialis anticus, and the peroneus longus muscles, and lower down betwixt the tibia and extensor policis longus, continues giving off branches in rapid succession, and when it arrives at the anular ligament, it is much diminished. Here it divides into the *ramus dorsalis*, *pedis profundus* and *superficialis*.— This division is made after the nerve has crossed under the tendon of the tibialis anticus muscle, and, while it lies betwixt the lower heads of the tibia and fibula.— Although they are distinguished by the name of deep and superficial branches, they are both deep compared with the extremities of the great and outer division of the peroneal nerve. The branch which lies most towards the outside of the foot, passes under the extensor digitorum brevis muscle, and on the outside of the tarsus. It distributes its branches to the extensor digitorum brevis, and interossii muscles. That branch which is more towards the inside of the foot, although distinguished by the term superficialis, goes forward not only under the fascia which covers the foot, but also under the tendons; and after dividing and again uniting, and after sending off some small branches, it comes out betwixt the great toe and the second toe, and sends numerous branches to their contiguous surfaces.

The GREAT SUPERFICIAL DIVISION of the FIBULAR NERVE is sometimes double, or immediately splits into two. Its first branches are to the peroneus tertius, extensor longus digitorum, and to the peroneus brevis and secundus. The trunk or principal division runs down under the head of the peroneus longus, and then com-

ing out from under it, continues its courſe beneath the ſtrong aponeuroſis, which covers the muſcles on the fore part of the leg. It then pierces the aponeuroſis and becomes cutaneous, and runs obliquely down to the convexity of the foot, giving off in its courſe a nerve which paſſes over the outer ancle.

THE METATARSAL NERVES.

WHEN the ſuperficial branch of the peroneal nerve deſcends before the ancle-joint, it divides into the metatarſal nerves, or the rami dorſales pedis. The EXTERNAL of thoſe branches paſſes above the tendons, and above the tendinous expanſion on the dorſum pedis; is united to the extreme branches of the ramus communicans tibiei, and is finally diſtributed to the outſide of the third toe, to the fourth, and to the inſide of the little toe.—The INTERNAL branch is again ſubdivided; one branch extends over the middle of the foot to the ſecond and third toes, while the other paſſes ſtraight along the metatarſal bone of the great toe (above the tendons); ſends many branches over the inſide of the foot, and terminates on the inſide and dorſum of the great toe.

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INTRODUCTION.

OF THE SENSES.

The Senses are those faculties by which the active principle within us has communication with the material objects by which we are surrounded. Through them, we receive those simple sensations which are the first elements of our thoughts, and the means of developing all the powers of the understanding. The exercise of our senses, however, is familiar to us from so early a period, that we never think of attending to their first simple intimations: before we are capable of reflecting on the nature of the perceptions which the several senses convey, they are so complicated and distorted by habits, association, and abstraction, that observation comes too late for us to ascertain the simple progress of nature. Philosophy may indeed revive the natural feelings of wonder at the spectacle of the universe; but often, instead of humble and

cautious inveſtigation, we follow the dictates of a creative imagination, and run into error and deluſion in ſtudying the operations of nature.

To the man, however, who looks upon nature with the calm and chaſtened delight which is the character of true philoſophy, there is a conviction, that ſuch reſearches may be carried too far. Wherever he directs his attention, whether to the ſtructure of the human body, the phyſiology of vegetables, or the phænomena of chemical ſcience; whether he endeavours to comprehend the ſyſtem of the univerſe, or pores over the minutiæ of natural hiſtory, he finds every where a limit placed to his enquiries; a line which no induſtry or ingenuity can enable him to paſs. We may pleaſe ourſelves with conjecture beyond this limit, but we find that all our opinions on theſe ſubjects are merely a dream of ſomething allied to the impreſſions of our groſs ſenſes. The agency of the ſenſes, the intercourſe betwixt mind and matter, and the influence of the will over the body, are myſterious, and, probably, inexplicable phenomena; yet we ſcruple not to explain them preciſely and mechanically; we reduce them to the level of our own capacity in the ſame manner as we fabricate to ourſelves the idea of a deity by the combination of all human perfections. When we imagine that we have diſcovered the ſecret of theſe myſteries, it is mortifying to find ourſelves without any ſign or language by which to communicate thoſe great truths to the companions of our ſtudies: We ſtruggle for expreſſion; and, as all our ideas upon ſuch abſtract ſubjects are derived from analogy, we expreſs our opinions reſpecting the powers of the mind,

or the manner in which we perceive the objects of the fenfes, in the fame language, and by reference to the fame notions, which belong to the fenfations themfelves. From this fcantinefs and inaccuracy of language, it unavoidably happens, that very different ideas of the operation of the fenfes are expreffed by feveral men in the fame terms; and in attempting to convey our ideas in language more precife and definite, we are infenfibly led to materialize the faculties of the mind, and to make the operations of the fenfes merely mechanical. What other explanation can we give of theories, which fuppofe the nerves to be tubes carrying animal fpirits, or containing an elaftic ether; or which reprefent them as vibrating cords, and reduce all the variety of fenfation to the difference of tenfion and tone? Thefe are, indeed, what Dr. Reid calls them, "unhandy engines for carrying images."

Nothing has been undertaken in philofophy but entire fyftems, fathoming at once the greateft depths of nature. The cuftom has been to frame hardy conjectures; and if upon comparing them with things there appeared fome agreement, however remote, to hold that as fully fufficient. What chimeras and monftrous opinions this method of philofophifing has brought forth, it would be more invidious than difficult to fpecify.

Bacon and Newton laid down the principles of philofophifing on this bafis, that on no account are conjectures to be indulged concerning the powers and laws of nature, but we are to make it our endeavour, with all diligence, to fearch out by experiment the real and true laws by which the conftitution of things is

 regulated.

regulated. In the ſubject now before us, we have a very remarkable proof of the ſuperiority of inveſtigation by experiment over the lazy indulgence of conjecture; and I hope the whole tenor of the following account of the ſenſes will ſtrengthen the conviction of the ſtudent, that it is only by aſſiduous ſtudy, and patient obſervation of nature, that he is to look for the attainment of knowledge in the medical profeſſion.

The office of the brain and nerves is to receive the impreſſions of external bodies, by which correſponding changes and repreſentations are made in the mind. We know nothing further than that, by the operation of the ſenſes, new thoughts are excited in the mind. Betwixt the ſenſation excited in the organ of the external ſenſe, and the idea excited in the brain, there is an indiſſoluble, though inexplicable, connection; the brain is not ſenſible, nor does the eye perceive, but both together give us the knowledge of outward things. But when the ſenſation is once received and communicated to the brain it is treaſured there, and may afterwards be excited independent of the external organ: hence comes the term internal ſenſes.

INTERNAL SENSES.

Though I treat profeſſedly of the external organs of the ſenſes only, it may be neceſſary here, to ſay a few words on the internal ſenſes. It appears that all ſenſations originate in the external ſenſes or organs receiving the impreſſions of outward bodies: imagination is the power of combining theſe ſenſations, and memory the power of recalling them. Theſe are

powers

powers of the mind, which, by the conſtitution of our nature, are gradually acquired, and encreaſed by exerciſe. In infancy, the perceptions are ſimple and tranſitory; the memory is perfected by degrees, and with the ſtore of ideas the imagination is invigorated.

It is in the combination and reciprocal effects of the mental powers and of the impreſſion on the external ſenſes, that we are to find an explanation of the operation of attention and its hiſtory. When the mental powers are led to the contemplation of an idea which aſſimilates eaſily with the ſenſation about to be preſented by the external organ, the perception is quick, and the idea vivid; but when the mind is ſtrongly impreſſed and occupied with the contemplation of paſt ideas, the preſent operation of the ſenſe is neglected and overlooked. Thus, the vividneſs of the perception or idea, is always proportionate to the degree of undiſtracted attention which the mind is able to beſtow on the object of ſenſation or of memory. In ſolitude and darkneſs, the ſtrength of the memory in the contemplation of paſt events is encreaſed, becauſe there is no intruſion of the objects of the outward ſenſes; and the deaf or blind receive ſome compenſation for their loſs in the encreaſed powers which are acquired by a more frequent and undiſturbed uſe of the ſenſes which remain, and a keener attention to the ſenſations which they preſent. On the other hand, when we are under the enchantments of a waking dream or revery, our attention is wholly detached from the preſent objects of the ſenſes; and in this ſtate we may even continue to read without underſtanding. This abſence, in a certain degree, is common,

 natural,

natural, and by no means unpleaſant: It is the exertion of the faculty of the mind. But it may become diſeaſe; for health conſiſts in the due correſpondence betwixt the excitement and the vigorous action of the body, and the operation of the mind when rouſed by the external ſenſes.

The mind (united to the body) ſuffers in the diſeaſes of the body. In the debility of the body, in fever, in ſpaſms, and pain, the faculties of the mind languiſh, or are rouſed to unequal ſtrength or morbid acuteneſs. Sometimes the phantaſms and internal ſenſations of things once received by the outward ſenſes, become ſo ſtrong in the mind, as to be miſtaken for objects actually preſent. Such phrenzy or delirium ariſes from a diſordered and acutely ſenſible ſtate of the internal ſenſes. Theſe impreſſions being great in degree, hurry and buſtle are in the countenance of the patient, and uncommon ſtrength and violence in his actions; as paſſion gives uncommon excitement to one in health, with a diſregard or forgetfulneſs of all other things. In health, however vigorous the force of imagination may be, there is ſtill a conviction that the ideas which it preſents are not realities, and the operation of the external ſenſes preponderates in recalling the attention to what exiſts around us. But when the internal perceptions become ſo ſtrong as to be miſtaken for realties, the effect is falſely attributed to the organs. It indeed ſometimes happens, that this falſe perception is really owing to diſeaſe in the organ; while it alſo occurs, that a too vivid perception of things abſent proceeds from an affection of the brain, and not of the outward ſenſes.

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There is ſtill another degree or claſs of diſeaſed ſenſation, conſiſting in the modification of objects which are actually preſent to the ſenſes. But this modification of things preſent (as when bodies actually at reſt appear to be in motion) is not always occaſioned by optical deception. Objects ſeem to turn round, and this we ſhall afterwards find to proceed from the inſenſible motion of the eyes; but this motion of the eyes is occaſioned by the diſordered ſtate of the internal ſenſation; and the ſame feeling will be experienced if the eyes are ſhut. For example, when we turn quickly round on our heel until we become giddy, it would appear that there is a diſturbance of the uſual order of ſenſation, and that the courſe of our impreſſions is reverſed; for while our ſenſations were formerly directed entirely by the impreſſion made on the outward ſenſes, the ſenſorial impreſſions now draw after them a ſympathetic motion of the external organs.

This inverted communication betwixt the mind and organs is better exemplified in the organ of ſpeech. Thoughts excited in the mind are repreſented by the ſigns of theſe ideas in ſpeech. There occurs, however, not unfrequently, a diſeaſed ſtate of theſe operations of the internal ſenſes, in which the ideas excited in the mind cannot be aſſociated with their appropriate expreſſions; and although the patient has a diſtinct idea of what he means to expreſs, he cannot recollect the words which belong to it; ſo that, when he aſks for one thing, he names another which has no connection with it. Of this he is perfectly ſenſible, and yet he cannot correct himſelf.

There are more frequent inſtances of diſeaſed corporeal ſenſation in hypocondriacs. In them, the ſenſation of pain and unuſual feelings are falſely attributed to parts in which there is really no affection: for theſe feelings there is no apparent cauſe; they proceed from a diſordered ſtate of ſenſation in which the uſual courſe of the impreſſions is altered, ſo as to occaſion the patient falſely to attribute his ſuffering to ſound and healthy parts. Thus indigeſtion, the irritation of the bile, flatulency, colic, &c. often do not give the uſual impreſſions, but the pains are attributed to outward parts. That there is ſometimes an actual connection exiſting betwixt the external parts, to which theſe feelings are referred, and the internal organs, is evident from the fact, that preſſure in the outward and ſound parts has occaſioned ſpaſms in the internal organs. To ſuch diſordered tranſmiſſion of the irritation of the internal parts we have to attribute the extravagant and ludicrous ideas which hypocondriacs entertain. In theſe people, there are diſeaſes of parts, of the action of which, during their healthy ſtate, (as I have already explained in the ſhort introductory view of the nervous ſyſtem), we have no feeling nor conſciouſneſs, and over which the will has no power. But although in the healthy ſtate of the œconomy there is no immediate route by which any ſenſation from theſe organs can be tranſmitted to excite a mental perception, it may happen, that, in their diſeaſed ſtate, when ſenſations do ariſe which forcibly attract the attention, there ſhould be an obſcurity in the feelings produced by their derangement, inſomuch, that the mind may be deceived in regard

regard to the direction of the ſenſation conveyed from them.

During health, there are viciſſitudes of conſciouſneſs, ſenſe, and voluntary motion, and of reſt from voluntary exertion, inſenſibility, and oblivion of the paſt. This is true, however, only comparatively, and by a groſs reference to degree; for even during natural ſleep there is not a total oblivion of paſt perceptions, nor is there always a total unconſciouſneſs of the preſent, as the ſenſes are in part awake; ſome one train of ideas is preſent to the mind; and the lapſe of time is obſerved. Even theſe perceptions are ſometimes ſo ſtrong as to be followed by voluntary exertion, and yet the patient remains aſleep. Whatever conduces to take the excitement from the mind, or leſſens the vivacity of its impreſſions, conduces to ſleep. Thus, reſt, ſtillneſs, and darkneſs, by excluding the moſt lively impreſſions conveyed by the ſenſes; and hæmorrhagy and evacuations, by leſſening the velocity of the circulation; induce ſleep. Again, compreſſion of the returning blood from the head, by giving it a ſlow languid motion, and by depriving the veſſels of their freedom of action, alſo conduces to ſleep; becauſe, as formerly remarked, the powers and faculties of the brain muſt be renovated through the means of the circulation.

By long watching and fatigue, the body is brought nearly to a feveriſh lowneſs. By ſleep, reſt is given to the voluntary muſcles, and an abatement of the vital motions enſues; the quieſcent ſtate of the muſcles brings back the blood to the heart, with a ſlow, regular, and calm progreſſion; the heart is reſtored to its

its ſlow and equable pulſation; the breathing becomes ſlower; and the waſted ſtrength of the ſyſtem is recruited.

We may define ſleep to be a ſtate in which the ſenſations are dull, the voluntary muſcles inert, and the vital motions calm and regular. In dreaming, the ſenſations are dull and obſcure, but the imagination more alive and active; unnatural ſleep, or ſoporific diſeaſes, may be characterized by the diſordered imagination, and diſturbed vital and voluntary motions. The vital actions, which are calm, ſlow, and equable, during natural ſleep, become oppreſſed; the ſenſibility, which is gradually diminiſhed upon the approach of ſleep, but always capable of being rouſed by the ſenſes, becomes quite oppreſſed; the voluntary muſcles continue relaxed, as in ſleep, or convulſed by irregular motions. In apoplectic diſeaſes, the functions of the viſcera proceed, and are but partially impeded; but when the circulation of the blood and play of the lungs are obſtructed, the operations of the mind are not equally unconcerned in the paroxyſm; for in ſyncope, the ſudden depletion of the blood veſſels of the brain cauſes inſtant loſs of ſenſe and of voluntary motion.

If natural ſleep is not profound, the imagination is awake; but there may be falſe perceptions, falſe judgment and aſſociations, and diſproportionate emotions; and if ſenſations are perceived, they do not produce the ordinary aſſociations. If ſuch a ſtate of the intellectual functions occurs during the waking ſtate, it becomes delirium. That this delirium is analogous to the perturbed ſtate of the imagination during ſleep, appears from the delirium in fevers uniformly ſhowing its ap-

proach

proach in the patient's ſlumbers only. It is a diſpoſition to form falſe images and aſſociations, which, in the beginning, the excitement of the outward ſenſes has power to counteract, inſomuch that a patient can be rouſed from delirium as he can be rouſed from ſleep: but, bye and bye, the external ſenſes loſe their ſuperiority, and their excitement is attended with unuſual aſſociations; they no longer convey impreſſions to the intellect, but become ſubſervient to and modified by it, and the judgment, which depends on the due balance of memory and imagination, is loſt. In fever, the delirium is tranſitory; in low fevers, it is combined with a comatoſe ſtate. In melancholy, the delirium runs upon one object chiefly, or trains of ideas, which refer to the patient's health and corporeal feelings. In madneſs, the variety is infinite; but chiefly conſiſting in a vitiated imagination and perverted judgment, with fierceneſs and encreaſed power of corporeal exertion.

There are five organs peculiarly adapted to convey ſenſations to the mind; and they may be conſidered as forming a medium of communication betwixt the external creation and the ſentient principle within us; they are at the ſame time the bond of union betwixt ſentient beings. Theſe organs are called the EXTERNAL SENSES; viz. the ſenſe of ſeeing, the ſenſe of hearing, the ſenſe of ſmelling, the ſenſe of taſting, and the ſenſe of touch. Individually, theſe organs convey little information to the mind; but by compariſon and combination, the ſimple and original affection or feelings of the mind are aſſociated and combined to infinity, and adminiſter to the memory and imagination, to taſte, reaſoning, and moral perception, the paſſions and affections, and every active power of the ſoul.

BOOK I.

OF THE EYE.

CHAP. I.

INTRODUCTORY VIEW OF THE PRINCIPLES OF OPTICS.

LIGHT is a matter thrown out from ignited, or reflected from ſhining, ſurfaces; and which enters the eye and impreſſes that organ with the ſenſation of ſight. The minuteneſs and inconceiveable velocity of light, the facility with which it penetrates bodies of the greateſt denſity and cloſeſt texture, without a change of its original properties, makes it the ſource of the moſt wonderful and aſtoniſhing phænomena in the phyſical world.

The ſmalleſt ſtream of light which propagates itſelf through a minute hole, is called a ray; and, as rays of light paſs through a uniform medium in a ſtraight courſe, they are repreſented by mathematical lines. The ſun is the greateſt ſource of light, and perhaps the original and only ſource. But light is not uniform in reſpect of colour: every part of a ray is not capable of

of exciting the idea of whitenefs which the whole raifes. White light is compofed of different kinds of rays, which individually give the fenfation: one of red, another of orange, a third of yellow, a fourth of green, a fifth of light blue, a fixth of indigo, and a feventh of a violet or purple *. Thefe are named the prifmatic colours; becaufe, in the fpectrum produced by making a ray of light to pafs through a prifm, thefe feveral colours are feen in the fucceffion in which they are above enumerated. Each of thefe rays individually impreffes the eye with its own colour; but when they all imprefs the eye at once, the fenfation upon the organ of fight is a compound effect: no individual colour is prefented, but that mixed light which is called whitenefs, and which may be divided into its individual colours by paffing it through a prifm.

It is the nature of moft bodies to abforb fome of thefe rays of light and to reflect others from their furface; confequently, the colours of bodies depend upon the particular rays which are reflected from them, or upon the combination of fuch rays as are reflected from them; and a body appears of that colour of which the light coming from it is chiefly compofed.

When a ray of light paffes from a rarer to a denfer medium, or from a denfer into a rarer, it alters its courfe,

* There is a fact not a little extraordinary regarding the emanation of rays from the fun, and which has been difcovered in the prefent day, viz. that there are invifible rays, giving heat but no light, which are lefs refractable than the coloured rays; and that all rays, in proportion to their refrangibility, have lefs power of producing heat. See Herfchel on the invifible rays of light. Phyf. Tranf. 1800, part ii. p. 284.

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if there be any obliquity in the original direction; but if it ſtrikes from one medium into another perpendicularly to the ſurfaces, its original direction is not changed. If the ray paſſing from the air enters obliquely into glaſs or water, or any denſer medium, it turns more towards the perpendicular; but if it paſſes through the glaſs and emerges again into the air, it reſumes its original direction, diverging from the perpendicular. This effect of different mediums upon the ray of light, is called refraction: when a ray of light impinging upon a ſurface does not enter, it riſes again to the angle of its incidence; and this is reflection.

The priſm is a piece of glaſs of a triangular form; the inclined ſurfaces of which, when placed in the courſe of the ray of light, refract, and ſeparate the ſeveral parts of the heterogeneous ray, and ſhow its compound nature. If the ſun be permitted to ſhine into a dark room through a ſmall hole in the window-ſhutter, and the beam of light be made to fall upon a glaſs priſm, it is, in paſſing through the glaſs, ſeparated into its conſtituent parts; becauſe the ſeveral coloured rays have different degrees of refrangibility, in the order in which I have already enumerated them. If the rays, after paſſing through the priſm, be made to paſs alſo through a convex glaſs, they are brought again to a point in the focus of that glaſs; and the effect of the whole colours thus reunited, is perfect whitneſs. We might ſuſpect that the beam of light were homogenous, and that the degree of refraction gave different colours to the rays, were it not proved, that how much ſoever any of the coloured rays is further refracted, it does not change its nature: nor

nor will rays ſuffer any change by reflection from bodies of different colours, for minium will appear yellow, green, blue, &c. according to the colour of the ray of light directed upon it *.

As the impreſſion of light remains ſome time upon the nerve of the eye, it gave Sir Iſaac Newton the opportunity of examining, whether each coloured ray makes a diſtinct impreſſion upon the eye, or whether they ſo affect each other as to impreſs the ſenſe of whiteneſs on the eye. When a burning coal is whirled in a circle, the eye perceives an entire circle of fire, becauſe the impreſſion made by the coal in any point of the circle remains until the coal returns again to the ſame place, and renews the ſenſation. When all the varieties of colours are painted in a circle, and turned in the ſame way with the burning coal, they muſt each make their ſeparate impreſſion upon the optic nerve; but the general ſenſation is whiteneſs; or when the teeth of a comb are drawn acroſs the ſtream of light iſſuing from a priſm, the different colours are intercepted in ſuch quick ſucceſſion, that a perfect whiteneſs is the reſult of the mixture of impreſſions. There are many experiments which ſhow, that the inequalities of the refraction of light are not caſual; that they do not depend upon any irregularity of the glaſs: on the contrary, it is proved, that every ray of the

* It is found, that the coloured rays have not all the ſame power of illuminating objects; the orange ray poſſeſſes this property more than the red; the yellow more than the orange, &c.; and the maximum of illumination lies in the brighteſt yellow or paleſt green; nor do the ſeveral rays equally affect the thermometer. See Herſchel's Exp. Phy. Tranſ. 1800, p. 2. p. 255.

ſun

ſun has its own peculiar degree of refractability, according to which, it is more or leſs refracted in paſſing through pellucid ſubſtances, and always in the ſame manner: and, laſtly, that the rays are not ſplit and multiplied by the priſm.

When a ray of light falls upon the ſurface of glaſs obliquely, it inclines to a line drawn (through the point of incidence) perpendicular to the ſurface.

Fig. 1.

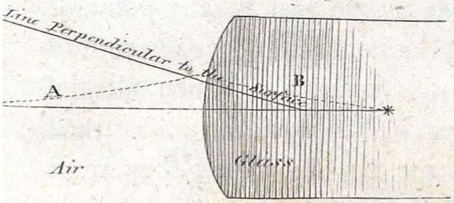
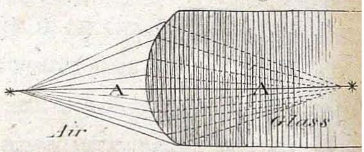


Fig. 2.



Thus the ray A. fig. 1., proceeding from the object ∗, is refracted upon entering the maſs of glaſs in the direction B, having a tendency towards the perpendicular line. By this means, if a number of rays proceeding from any one point, as in fig. 2., fall on a convex or ſpherical ſurface of glaſs, they will be inflected ſo as to gather about the perpendicular line A A in the centre of the glaſs: which perpendicular line is the axis of the glaſs. If the rays of light proceeding from an object be made to ſtrike into a maſs of glaſs with a concave ſurface, the obliquity with which they impinge upon the ſurface, being the reverſe of the convex

convex ſurface, they are not made to converge upon the central line, but diverge from it.

Farther, the rays of the ſun when paſſing from a medium of glaſs into the air, are turned, by refraction, farther off from the central line to which they were drawn in entering the convex ſurface of glaſs. But if the rays, in paſſing through the glaſs, were in a direction converging to the perpendicular line, they will be made to converge ſtill farther, as is ſeen here in fig. 3.

Fig. 3.

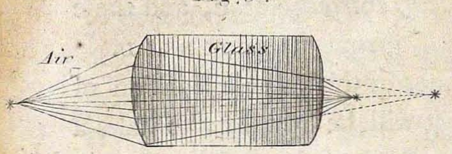
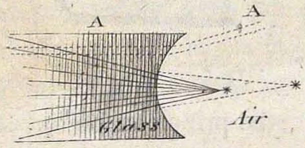
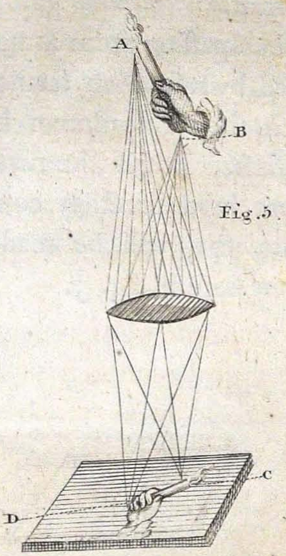


Fig. 4.



If, however, the rays be made to paſs from glaſs into the air, and the ſurface of the glaſs be concave as in fig. 4., the rays will be made to have a leſs degree of convergence, ſo as to remove the image * farther from the ſurface of the glaſs. But if the rays paſſing through the medium of glaſs have no convergence, but paſs in parallel lines, they will diverge as the lines A A, fig. 4. do, when they emerge from the concave ſurface of the glaſs.

We ſee, then, the operation of a double convex glaſs, in forming the image of a luminous body upon a ſurface. If, for example, ſuch a glaſs be held between a candle and a piece of white paper, (the diſtances being properly adjuſted), the image of the candle will appear very diſtinctly upon the oppoſed ſurface, but inverted; becauſe the rays coming from the point A fig. 5., converge at C, and thoſe from the point B at D.



Before proceeding farther in this ſhort expoſition of the principles of optics, it will be neceſſary to take a very ſlight view of the ſtructure of the eye.

SIMPLE IDEA OF THE STRUCTURE OF THE EYE.

THE eye being that organ by which we are ſenſible to the rays of light, may be conſidered as conſiſting of two parts; that which receives the impreſſion, viz. the retina or expanded nerve, and which is indeed the organ of the ſenſe; and the tunics and humors, the apparatus by which the rays of light are made capable of forming an impreſſion on the retina, or proper organ of the ſenſe.

In an anatomical enquiry, it is chiefly the latter diviſion of the ſubject which muſt occupy our attention; for,

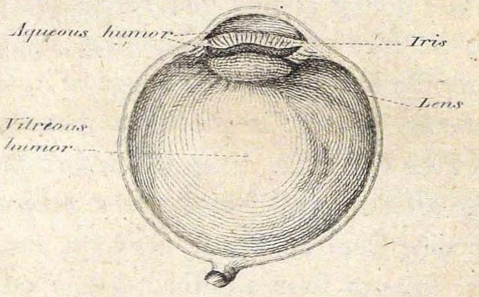
for, although we are neceſſarily led to conſider the nature of the ſubſtance of the retina, the manner in which it is expanded, and ſupported by adheſion, and nouriſhed by veſſels, we muſt not venture far in the attempt to inveſtigate the manner of its receiving or conveying the image of objects to the ſenſorium. We muſt turn to inveſtigate the more uſeful ſubject of the ſtructure, uſe, and diſeaſes * of the humors and coats of the eye.

It is the firſt principle of the conſtitution of the eye, that the rays of light muſt be ſo concentrated as to impinge ſtrongly on the expanded nerve or retina in the bottom of the eye. Now, as we have ſeen, that a lens (which is a double convex glaſs) is neceſſary, ſo to concentrate the rays of light proceeding from an object, as to form a ſmall and lively image of it, (as in marginal plate, fig. 5.), ſo, in the ſame manner, an eſſential part of the eye is the lens, which brings the rays of light to a focus; and that the lens may make the rays proceeding from an object converge into an accurate focus, ſo as to form a diſtinct image on the eye, the vitrious humor is interpoſed betwixt the lens and the ſurface of the retina: again, it is neceſſary to the conſtitution of the eye, that, in order to encreaſe the ſphere of viſion, the anterior part of it ſhall project and form a large ſegment of a ſmall circle, ſo as to take a greater circumference into the ſphere of viſion than could have been done, had the larger ſphere of the eye-ball been continued on the fore part. Another neceſſary part of the apparatus of the eye is the iris,

* Of the diſeaſes only as they relate to the explanation of the ſtructure and œconomy of the eye.

which is a curtain in the anterior chamber of the eye, perforated with a hole, which is capable of being enlarged or diminifhed fo as to admit a larger or fmaller ftream of light as may be neceffary to perfect vifion. In this provifion, we fee the neceffity of the anterior humor of the eye being different from the others; being merely an aqueous fecretion, while the others poffefs a degree of firmnefs, viz. that the iris, or curtain of the eye, may move with perfect freedom in it.

Fig. 6.



The three humors of the eye are thus fituated, and have this general character:

1. The AQUEOUS HUMOR is the anterior humor of the eye. It diftends the anterior and pellucid part of the eye, fo as to encreafe the fphere of vifion. It is perfectly fluid, and of a watery confiftence, that it may allow free motion to the iris.

2. The

2. The LENS OR CHRISTALLINE HUMOR is placed immediately behind the perforation in the iris; which perforation is called the pupil. The lens collects the rays of light like a double convex glafs, fo as to concentrate them, and make a more forcible image on the bottom of the eye.

3. THE VITRIOUS HUMOR is behind the lens. It diftends the general ball of the eye into a regular fphere, that it may move eafily in the orbit; and its diameter in the axis of the eye is fo proportioned to the focal diftance of the lens, (affected alfo in fome degree by the other humors), that the image of an object is formed accurately on the furface of the retina: accordingly, when the coats are cut from the back of the eye, the picture of a luminous object held before the pupil is feen exquifitely minute and diftinct on the bottom of the eye.

While thefe humors have each its diftinct character, they poffefs, in proportion to their denfity, different powers of refracting the rays of light. This has the ftill farther good effect of correcting the aberration of the rays and giving the trueft colours, as well as the moft correct image of the object prefented to the eye.

If the lucid anterior part of the eye be formed too prominent, or if the lens of the eye have too great a degree of convexity, or, laftly, if the fize of the ball of the eye, and the diameter of the vitrious humor in the axis of the eye be unufually great, then the perfon does not fee diftinctly; becaufe the powers of the humors, in concentrating the rays of light, are too great, and the image of the object is not formed ac-

curately on the retina, but before it. Thus, in fig. 7., the convexity of the cornea, the lucid anterior part of the eye, or the focal powers of the lens, being too great for the length of the axis of the eye, the image is formed at A before the rays reach the surface of the retina; and after coming accurately to the point, they again begin to diverge; which diverging rays, ftriking the furface of the retina, give the indiftinct vifion of a near-fighted perfon. But as this indiftinctnefs of vifion proceeds from no opacity, but only the difproportion of the convexity of the eye to the diameter, the defect is corrected by the concave glafs, A fig. 8.; for, the effect of this glafs being the reverfe of the convex, it caufes the rays to fall upon the furface of the eye, fo far diverging from the perpendicular line, (which is exemplified in fig. 1.), as to correct the too great convergence caufed by the convexity of the humors. But, when a near-fighted perfon has brought the object near enough to the eye to fee it diftinctly, he fees more minutely, and, confequently, more clearly; becaufe he fees the object larger, and as a perfon with a common eye does, when affifted with a magnifying glafs or convex lens.

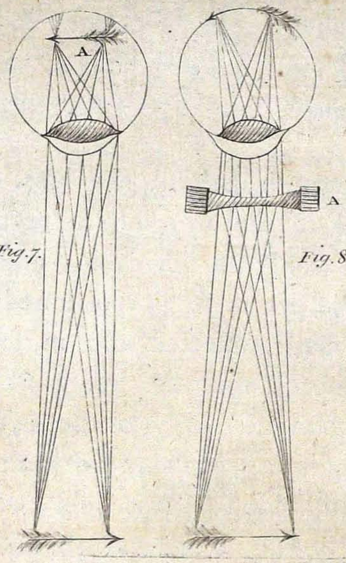


Fig. 7. Fig. 8.

3 The

The near-ſighted perſon ſees diſtant objects indiſtinctly; and as the eye, in conſequence, reſts with leſs accuracy upon the ſurrounding objects, the piercing look of the eye is diminiſhed, and it has a dulneſs and heavineſs of aſpect. Again, the near-ſighted perſon knits his eye-brows, and half cloſes his eye-lids: This he does to change the direction of the rays, and to correct the inaccuracy of the image, in a manner which may be underſtood by the following analogy. If we make a card approach a ſtream of light paſſing through the window, it will ſo attract the rays of light, as to extend the margin of the figure of the circular ſpot of light upon the wall. In the ſame way, when a ſtream of light, proceeding from an object towards the eye, is made to paſs through a ſmall hole, the circular margin of the hole ſo attracts the rays, as to produce the ſame effect with the concave glaſs; by cauſing the rays to take a direction outward, as if proceeding from a nearer object, the image is carried farther back from the lens; and when a near-ſighted perſon peers through his eye-lids, it makes the rays impinge accurately upon the retina *.

* Short-ſightedneſs may be produced by accidents. Sometimes I have known it produced by a piece of glaſs ſticking in the cornea, and cauſing great inflammation. Dr. Briggs mentions the caſe of an old man, who had long uſed ſpectacles, becoming ſuddenly ſhort-ſighted, by catching cold, and he was afterwards enabled to read the ſmalleſt print without glaſſes. In general, however, it is by ſome accident, and often late in life, that we become ſenſible of being ſhort-ſighted; and, in this caſe, men are very apt to attribute the defect to ſome particular occurrence.

The effect of old age, is gradually to reduce the eye to a leſs prominent ſtate, and, conſequently, to bring it to the reverſe of the near-ſighted eye.

From the decreaſe of the humors, and the leſſened convexity of the cornea, the image of objects is not formed ſoon enough to impinge accurately on the retina, the rays tend to form the image behind the retina, as we ſee in fig. 9.

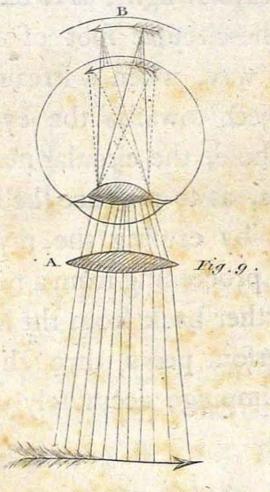


Fig. 9.

In this figure, we have the effect of old age on the humors repreſented; without the intervention of the glaſs A, the rays have a direction which would form the image at ſome diſtance beyond the retina, as at B. But by the convex glaſs A, (which is of the nature of the common ſpectacles for old people), the direction of the rays of light is ſo corrected, that the image falls accurately on the bottom of the eye.

We underſtand, then, whence theſe oppoſite defects of ſight ariſe; that, in old people, objects cannot be ſeen diſtinctly when near, and, in ſhort-ſighted people, they cannot be ſeen diſtinctly when at a diſtance. We ſee, alſo, why old age corrects ſhortſightedneſs by gradually reducing the convexity of the eye, enabling the perſon to ſee objects farther removed, until,

until, by degrees, he comes to ſee perfectly at the diſtance moſt convenient for the common affairs of life.

It has been, by ſome, thought extremely difficult to account for the image appearing to us, as it is in nature, erect, ſince it is actually figured on the bottom of the eye in an inverted poſture; but the terms above and below have no relation to the image in the bottom of the eye, but to the poſition of our bodies and the ſurrounding things. When I look to a tall man's face, I direct my eyes upward; I obſerve his ſituation, as it relates to an ideal area before my eye, or to a ſpace in the ſphere of viſion.

When an object approaches towards the eye, the diameter of the picture on the retina encreaſes in the ſame proportion as the diſtance between the eye and the object decreaſes; and, conſequently, it decreaſes in the ſame proportion as the diſtance encreaſes. But the degree of brightneſs of the picture of an object on the retina continues the ſame at all diſtances, between the eye and the object, unleſs ſome of the rays of light are interrupted in their progreſs; for, as the advancing object becomes bright, it encreaſes doubly in length and breadth, or quadruply in ſurface. The faint appearance of remote objects, therefore, is occaſioned by the opacity of the atmoſphere.

There is nothing more aſtoniſhing in the ſtructure of the eye, than the ſenſibility of the expanded nerve, as proved by the extent of the changes or degrees of light which illuminate viſible objects; or the great degree of light which the eye can bear, and the low degree of light at which objects are viſible. Thus, the proportion betwixt the degrees of light illuminating an object

object by the ſun, and by the moon, at any equal altitudes, is calculated at 90,000 to 1 *. Again, by M. de la Hire's calculation, we ſee the ſail of a windmill, ſix feet in diameter, at the diſtance of 4000 toiſes. The eye being ſuppoſed to be an inch in diameter, the picture of this ſail, at the bottom of the eye, will be $\frac{1}{8000}$ of an inch, which is the 666th part of a line, and is about the 66th part of a common hair. This gives us an idea of the minuteneſs of the ſtructure of the optic nerve.

The pupil of the eye is formed by the central perforation in the iris or curtain, which hangs before the lens. This body having muſcularity, is moveable; it dilates or contracts the hole or pupil, tranſmitting the rays ſo as to adapt the diameter of the ſtream of light, darting into the eye, to the intenſity or degree of light. If a body is illuminated but faintly, the pupil is (inſenſibly to us) enlarged, and a greater quantity of the rays are allowed to be tranſmitted to the retina. But as the convexity of the pellucid part of the eye, and the concentrating powers of the lens, remain the ſame, the ſize of the image is not altered by this dilatation of the pupil, but only the ſtrength of the image or picture in the bottom of the eye is encreaſed.

We underſtand that the rays of light are refracted, when they paſs out of one medium into another of different denſity.—For example, the rays of light are refracted towards the perpendicular line, when they enter the cornea of the human eye; but they will be refracted in a very ſmall degree in entering the cornea

* See Smith's Optics, vol. i. p. 29.

of

of fiſh, becauſe the aqueous humor is of the ſame denſity with the fluid from which the rays of light are tranſmitted; accordingly, the cornea of fiſhes is not prominent: this would limit their ſphere of viſion, were not the flatneſs of the cornea counteracted by the prominence of the whole eye, and the more anterior ſituation of the chryſtalline lens; a large pupil and long diameter of the eye we ſhall afterwards find to be neceſſary to the diſtinct viſion of fiſhes *.

It is natural, on the preſent occaſion, to inquire into the effects of the ſeveral humors of the eye, in producing in thoſe who are ſhort-ſighted, the obſcurity ariſing from the double appearance of ſmall and ſhining points. This is prettily explained by Jurin, upon Sir Iſaac Newton's principle, concerning the fits of eaſy refraction and reflection of light.

The horns of the new moon, or the top of a diſtant ſpire, or the lines upon the face of a clock, appear double or triple, and ſometimes much more multiplied, to a ſhort-ſighted perſon. The ſame appearance will be given when an object is held too near the eye, for perfect viſion. If the light is ſeen through a narrow ſlit in a board, and the board is brought nearer to the eye than the point of diſtinct viſion, the aperture will

* Neither fiſh out of water, nor other animals within water, can ſee an object diſtinctly. Divers ſee objects as an old man would do through a very concave glaſs put near to the eye; and it has been found, that the convexity of ſpectacles for divers in the ſea muſt be that of a double convex glaſs, equal on both ſides to the convexity of the cornea. The neceſſity of this is plain; the aqueous humor being of the ſame denſity with the water, there is in it no refraction, and this deficiency muſt be ſupplied.

appear

appear double, or as two luminous lines, with a dark line between them; and as the diſtance is varied, two, three, four, or five dark and luminous lines will be obſerved. There are many ſuch deceptions in viewing luminous bodies; all of them proceed from the ſame cauſe, which is this :—Before Sir Iſaac Newton's philoſophy was acknowledged, it was the received opinion, that light was reflected from the ſurface of bodies by its impinging againſt their ſolid parts, and rebounding from them like a tennis-ball when ſtruck againſt a hard and reſiſting ſurface: further, as they ſaw that part of the rays of light were in glaſs reflected, and the reſt tranſmitted, they conceived that part entered the pores of the glaſs and part impinged upon its ſolid parts. But this does not account for the refractions which take place when the rays have paſſed the glaſs, and are about to be tranſmitted into the air, they cannot find ſolid parts to ſtrike againſt in entering the air, for the refraction of the light is greater in paſſing from the glaſs into the air, than from the air into the glaſs; and if water be placed behind the glaſs, the refraction of rays paſſing out from the glaſs is not encreaſed but diminiſhed, by this ſubſtitute for the rarer medium of the air. Again, when two glaſſes touch each other, no refraction is made in rays paſſing from the one into the other. To explain this, Sir Iſaac Newton taught, that in the progreſs of rays of light, there is an alternation of fits of eaſy tranſition or reflection; or, in other words, that there is a change of diſpoſition in the rays, to be either tranſmitted by refraction, or to be reflected by the ſurface of a tranſparent medium.

Jurin

Jurin illuſtrates this opinion, and its application to our preſent purpoſe, in this manner.

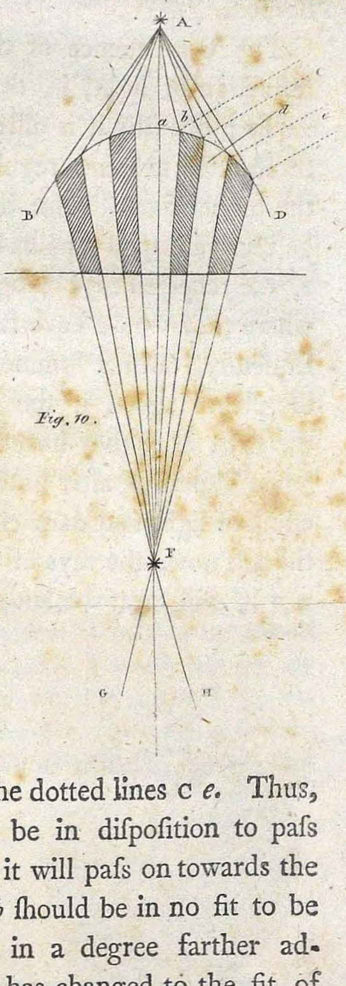


Fig. 10.

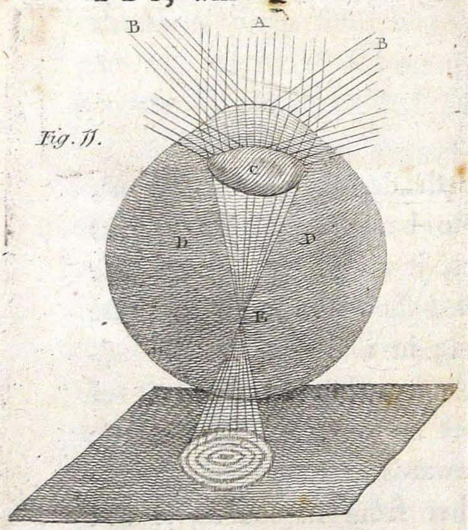
Suppoſe that A B D, and B D F, are mediums of different denſity, and that their ſurfaces are interceded by the line B D; again, let A be a pencil of rays, which, iſſuing from this point, falls upon B *a* D, as the refracting ſurface B *a* D is convex, and no two points of it, from *a* to D, are equally diſtant from the ſource of the rays A; and, as the rays of light, in their progreſs, alter alternately from the fit of refraction to the fit of reflection, they muſt be in part refracted to the focus F, and reflected in the direction of the dotted lines C *e*. Thus, if the ray A *a* happens to be in diſpoſition to paſs through the medium B D F, it will paſs on towards the point F. If the next ray A *b* ſhould be in no fit to be tranſmitted, becauſe, being in a degree farther advanced from its ſource A, it has changed to the fit of reflection, then it will not be refracted towards the focus F, but reflected off towards *c*; but, again, the ray A D being advanced farther from its ſource, it will impinge upon the ſurface B D, during its diſpoſition

to

to refraction, and will concentrate its beams at F; and ſo with all the others, alternately reflected and refracted.

The conſequence of this obſtruction to the equal refraction of light, is, that the image formed at F is feeble; but ſtill it is diſtinct and perfect; becauſe the tranſmitted rays are regularly concentrated, and form the proper focus. But if the converging rays ſhould be received upon a plain before they arrive at the focus F, the reflected rays of light will have left ſpaces dark, where they would have fallen by refraction, and, conſequently, diſtinct luminous circles will be thrown on the plain: again, if the plain ſurface be oppoſed to the rays, after they have formed their focus, and are again diſperſing after having croſſed, the ſame unequal effect of light and dark circles will be thrown on it; though now, the rays of the right ſide of the pencil B D F, will form the left of the pencil F G H.

Fig. 11.



How the changeable ſtate of the rays produces the indiſtinctneſs of the near-ſighted eye, may be underſtood from this (11.) diagram. When the rays A ſtrike the convex ſurface of the cornea, part of them will be reflected from the ſurface of the cornea, in the direction of the lines B B, when they will conſequently ſtrike upon the convex ſurface

ſurface of the lens in luminous rings, theſe rings will be ſtill farther multiplied and diminiſhed in diameter, in being in part tranſmitted, in part reflected, from the ſurfaces of the lens *c*, and vitrious humor D D. Theſe effects of the alternate diſpoſition of the rays for tranſmiſſion and reflection would not be perceptible, did the converging powers of the cornea and lens bring the focus of the rays exactly to the ſurface of the retina; but as the focus is formed at E, ſome way before the retina, the rays have decuſſated and ſpread out again before they form the image upon the bottom of the eye. Inſtead, therefore, of forming an accurate image, they are ſpread out into concentric circles; or in a leſſer degree, the perſon experiences a confuſed outline of the object, which becomes ſurrounded with ſeveral rings or falſe outlines *.

* By *fits of eaſy tranſition*, it was not meant by Sir Iſaac Newton that the rays muſt neceſſarily be tranſmitted through every pellucid medium, and at any obliquity of incidence, but only that the ray was more eaſily tranſmitted and more difficultly reflected; nor was it meant that, during its *fit of eaſy reflection*, it was abſolutely incapable of being tranſmitted, but only more readily reflected than tranſmitted.

CHAP. II.

OF THE COATS OF THE EYE.

SPEAKING generally, and without confidering the minuter divifions of anatomifts, we may fay, that there are three proper coats of the eye, viz. the SCLEROTIC COAT, giving ftrength; the CHOROID COAT, being the vehicle of the chief vafcular ftructure of the eye; and the RETINA, or expanded nerve, being the organ itfelf. Thefe are the proper coats of the eye; but there are others which may be called the partial or acceffory coats, being thofe which do not completely furround the eye, viz. the ALBUGINEA and CONJUNCTIVA *. There are others, ftill, which are called capfular coats; and thefe are the tranfparent tunics which immediately furround the humors, as the capfule of the lens and pellucid membrane of the vitrious humor.

Although many of thefe coats may be capable of being divided by the art of the anatomift, either by the knife, by injections, which form extravafation between their layers, by maceration, or by the chemical action of fluids; yet it is better, in a general enumeration, to take a natural divifion and character, than to enumerate their feveral lamina.

* Colombier Sandifort Thef. Differt.

OF

OF THE SCLEROTIC COAT.

The ſclerotic coat is ſo called from its hardneſs *. The ſclerotica and cornea are often conſidered as one continued coat inveſting the eye; hence they ſay, the opaque and the lucid cornea. But, although theſe parts are actually in union, yet as they are really of ſo very different a nature, we muſt conſider them apart, and treat at preſent only of the opaque white ſclerotic coat.

The ſclerotic coat is a ſtrong, firm, and white membrane, conſiſting of lamellæ firmly attached and interwoven, and not capable of being regularly ſeparated by maceration; it has the denſeneſs of tanned leather. In firmneſs, whiteneſs, opacity, and the little appearance of vaſcularity, it more reſembles the dura mater than any other membrane of the body.

In adults, the ſclerotic coat is ſtronger and firmer, comparatively, than in the fœtus; the cornea leſs ſo. On the outer ſurface, it has (towards the orbit) a looſe cellular membrane attached to it, which allows the motion of the eye-ball. Upon the fore part, it is inveſted by the tunica albuginea or tendinea. Upon its inner ſurface, it has a looſe and ſoft membrane which connects it with the choroid coat.

In birds, and the tortoiſe, the poſterior part of the ſclerotic coat is thin; the fore part of it is ſplit into laminæ, betwixt which there are interpoſed thin plates

* Dura ſeu ſclerotica; Veſalius, Ruyſch, &c.

 of

of bone *, while in fiſhes it is in part cartilaginous †, but thin and tranſparent, ſo that there appears a very beautiful ſpotted coat beneath it. There are alſo ſeen in the ſclerotic of fiſhes little white granules like glands.

The vagina of the optic nerve can be ſeparated into two laminæ §; the outer one is obſerved to unite intimately with the outer part of the ſclerotic coat, while the inner lamina of the vagina is continuous with its inner ſurface. The pia mater, too, ſays Zinn, when it has pierced the foramen in the ſclerotic coat, alongſt with the ſubſtance of the nerve, expands upon the inner ſurface of this coat, and extends even to the cornea, and forms one of its intimate laminæ. This muſt be only that part of the pia mater which inveſts the optic nerve, or, more ſtrictly ſpeaking, that membrane which ſtands in the ſame relation to the nerve that the arachnoid coat does to the brain; for the membrane, which ſinks into intimate union with the nerve, accompanies it even in forming the retina ‡.

The

* Cuvier, vol. 1. p. 387.

† Morgagni Epiſt. An. xvi. 40. Cuvier, 388.

§ Ruyſch, Zinn.

‡ It may be well, in this place, to detail at once the opinions of the chief ſupporter of that ſcheme of the coats of the eye, which derives them all from the inveſting membranes of the brain and optic nerve. M. le Cat, in his *Traité des Sens*, deſcribes them thus:—When the optic nerve has entered the orbit, the dura mater, which ſurrounds it, ſplits into two laminæ; the external one attaches to the orbit, and forms the perioſteum, the other forms the vagina of the nerve. In the angle formed by theſe, the muſcles of the eye ariſe. This continued ſheath of the nerve, he continues, expands into the globe of the eye, as the maſs of glaſs is blown into a bottle. The dura

The ſclerotic coat is the great ſupport of the globular figure of the eye; it defends the more delicate internal ſtructure from ſlighter injuries, by its ſtrength; and from the progreſs of inflammation, by being of a ſtructure but little vaſcular, and not prone to diſeaſe. That inflammation which we ſee to be ſo frequent in the eye, is not in the ſclerotica, but in the adventitious coat, the conjunctiva. But in proportion as the ſclerotic coat reſiſts preſſure and the progreſs of diſeaſe from without, it reſiſts the ſwelling of the parts within when they become diſeaſed, and gives the greateſt torture.

Of what importance the entireneſs of the coats, and the uniform reſiſtance of the humors of the eye is to the healthy ſtate of the organ, will be afterwards examined.

OF THE CORNEA.

The cornea is ſo called, from being firm, tranſparent, and compoſed of laminæ *. It is the pellucid

dura mater of the nerve is expanded into the cornea (viz. ſclerotica). The ſecond envelope, or pia mater, forms two laminæ; the one is applied to the ſclerotic coat, and the other forms the choroid coat. The choroid coat divides anteriorly, and forms the iris and ciliary proceſſes. The internal medullary part of the optic nerve forms the retina. Finally, "L'œil eſt tres evidemment l'extremité nerveuſe "epanouie bourſouflée en Bouton creux & plein de liqueurs." p. 158.

* "Cornu modo dura, & cornu inſtar in laminas dividi radique "poteſt." Veſſalius.

circle on the fore part of the eye, which ſeems variegated with colours; though this is a deception, owing to its perfect tranſparency. The circle of the cornea is, however, far from being regular; its margin is flat towards the noſe.

The cornea conſiſts of laminæ; betwixt which, there is interpoſed a cellular ſubſtance, filled with a perfectly pellucid fluid *. Theſe cells ſeem, like the common cellular membrane of the body, to have a free communication with each other, ſo that the fluid freely exudes, and as quickly is imbibed, by maceration. The fullneſs of the cornea, with the perfect tranſparency of the fluid, gives a brillancy to the eye, and is a ſign of health; the reverſe dims the eye, and, with the fallen features, accompanies ill health. Steno obſerved, and Petit confirmed, the fact †, that the pores on the ſurface of the cornea exuded the fluid which fills the cells of the cornea; and that, after the ſurface was carefully dried by preſſure, the moiſture might be ſeen to form in drops upon the ſurface. The moiſture can be thus forced out from the pores of either ſurface of the cornea ‡. This moiſture becomes dull and clamy on the approach of death, and forms ſometimes a pelicle over the cornea. The laxity with which the laminæ of the cornea are connected, may be, in ſome meaſure, demonſtrated, by taking it betwixt the finger and thumb; we ſhall then find, that the layers can be made to glide very freely on each other. In the fœtus, and in young children, the cornea is of great thickneſs,

* Subſtantia ſpongioſa Valſalvæ.

† See alſo Hovius, p. 82.

‡ Zinn.

and reſiſts the point of the lancet or ſcizzars. This reſiſtance in the fœtus proceeds from a great degree of toughneſs, while, in the adult, the ſurface of the cornea is ſo hard, that I have often ſeen the point of the knife, in extracting the cataract, bend upon it. This turning of the elaſtic point of the knife is very apt to give a wrong direction to the inciſion; and, indeed, this occurred to me in my firſt operation.

There is a pelicle, or exceedingly thin coat, which, by maceration, can be taken off from the ſurface of the cornea. This is generally underſtood to be the conjunctiva continued over it. But I cannot help expreſſing myſelf as averſe to the ideas of thoſe anatomiſts who conſider every membrane, which can be traced from another by diſſection, as either derived from it, or in any way allied to it. This can ſurely ſerve no uſeful purpoſe, if, as here, the membranes differ in their uſe; are changed in their appearance; and have no ſimilarity in ſtructure, function, or diſeaſes.

The membrane in fiſhes, analogous to the adnata, lies looſe over the cornea; and, in ſerpents, it is thrown off from the cornea, with the ſcales of the body, and remains attached to the caſt ſkin of the head; and in the fœtus calf, I have forced the blood in the veſſels of the conjunctiva into veſſels paſſing over the ſurface of the cornea.

By maceration, I have found, raiſed in the fluid, a very delicate and tranſparent membrane from the inner ſurface of the cornea; and, after long continued ſoaking, the whole cornea can be taken out of the ſclerotic coat, like an optician's glaſs from its frame.

The cornea poſſeſſes great ſenſibility; although much of the pain, from hard bodies flying into the eye, is to be attributed to the motion of the eye-lids, and the great ſenſibility with which they are endued. When a ſplinter of glaſs or metal ſtrikes and ſticks in the cornea, inflammation is excited; in conſequence of this, veſſels carrying red blood ſtrike into it, or ſhoot over its ſurface in a new film of membrane *. Petit thought he obſerved firſt in a negroe, and afterwards in a variety of inſtances, red lines in the cornea; which he conceived to be the anaſtamoſing of veſſels. There are, beſides, ſays he, many circumſtances which argue that there are blood-veſſels in the cornea. When the eye receives a ſtroke, there is often blood effuſed in its ſubſtance; abceſſes, alſo, are found within it, and phlyctænæ on its ſurface; and in great inflammation of the eye, the cornea appears red; which, he ſuppoſed, muſt be produced by the ſame cauſe which makes the albuginea red, viz. the enlargement of its veſſels, and the circulation of red blood. But we muſt not imagine, he continues, that, in the natural ſtate, red blood circulates in the cornea; for the veſſels are not to be ſeen with the microſcope; nor are they penetrated by injection; nor do they appear in the fœtus; nor, when little abceſſes are formed in the cornea; but only when violence has been done by a ſtroke upon the eye. In an eye in which the tunica

* I have found the ſpark from iron, in blackſmiths and maſons, buried in the cornea for ſeveral days (ſome authors ſay months), without exciting pain or much inconvenience. I have alſo more than once picked a little black ſlough from the cornea, miſtaking it for a piece of iron, when it was only the conſequence of the injury.

conjunctiva

conjunctiva was most minutely injected, as well as the internal vessels of the eye, I had resolved, carefully to examine the structure of the cornea; and after a long maceration, in which it had greatly swelled, I observed a set of vessels totally distinct from the extremities of the minute blood-vessels. The minute blood-vessels which were injected, stopt abruptly on the margin of the cornea. But these I now mention are particular; they are in great profusion, large, and perfectly pellucid; they are large towards the middle of the cornea, and diminish towards the margin. Their free communication formed a net-work deep in the thickened substance of the cornea. The size, perfect pellucidness, and intimate connection of these vessels, might perhaps incline one to call this a cellular structure.

Mr. Home * says, that an irritation on the edge of the cornea, and which includes the tunica conjunctiva, will produce greater inflammation, and more quickly, than a stronger excitement would produce on the centre of the cornea. This remark is probably from observation; but he adds, it is impossible that the vessels of the cornea, which naturally carry lymph only, or serum, can be made to carry red blood, unless the irritation extends to some neighbouring part supplied with red blood. This, certainly, is an erroneous idea; for the little opacities which surround spiculæ sticking in the cornea, the ulcerations on its surface, and little abcesses within its layers †, are the effect of inflamma-

* Philos. Trans. 1797, p. 20.

† Viz. Onyx, unguis, an abcess between the laminæ of the cornea, from a supposed resemblance to the figure of a nail pared from the finger.

 tion

tion of the part modified by its peculiar ſtructure ; and theſe will all take place while the margin of the cornea remains clear, and there is no apparent connection of inflammation, or of veſſels with the conjunctiva.

Veſſels attach themſelves both to the inner and to the outer ſurface of the cornea ; and when it becomes ſpongy and vaſcular in this way, little can be explained of its natural ſtructure. Thus, the pannus and pterygium are membranes which ſtretch acroſs and adhere to the cornea, while the iris frequently attaches to its inſide. In this caſe, the cornea becomes ſpongy, thick, and vaſcular ; and, when cut, there is red blood in it * ; and in ſtaphyloma †, the iris is generally attached to the cornea. I have a preparation in which the form and character of the iris is entirely loſt ; it is extended into a reticulated membrane which lines the ſurface of the extended cornea.

OF THE CHOROID COAT.

The choroid is the vaſcular tunic of the eye ; it is ſo called from its reſemblance to one of the membranes of the ſecundines. It is the middle coat of the eye, lying betwixt the ſclerotic coat and retina. Injections ſhow it to conſiſt of two layers of cellular

* Pterygium, is a membrane which extend sover the cornea from the canthus. Pannus, is a congeries of blood veſſels, which extends over the cornea, and is leſs uniform than the pterygium.

† Staphyloma uvea, a protruſion and opacity of the cornea ; which, from the loſs of tranſparency and the general appearance of the tumor, is ſuppoſed to reſemble a grape.

tiſſue ;

tiſſue; and it has upon its inner ſurface a pigment, which being ſometimes firm, might be taken for a membrane. It was Ruyſch who obſerved this diviſion of the choroid coat into two laminæ; and the inner one, his ſon called the tunica Ruyſchiana: but of theſe hereafter.

Thoſe anatomiſts who ſuppoſed the ſclerotic coat to be the production of the dura mater, naturally concluded, that the choroid coat was derived from the pia mater; and as Ruyſch found it to be diviſible into two laminæ, ſo Sladius found the pia mater to conſiſt of two membranes. It followed, that the one lamina of the choroid coat was the continuation of the tunica arachnoides, and the other of the pia mater; but this account of theſe membranes has no ſupport from obſervation. Betwixt the pia mater and choroid coat, there is no reſemblance; the latter we ſhall find loaded with veſſels; but theſe veſſels are peculiar, and miniſter to a ſecreting ſurface. The pia mater in the brain, and optic nerve, is in ſtrict union with the ſubſtance of the brain, and ſupports and nouriſhes it; but the choroid coat has no connection with the retina or expanded nerve.

There can be no better mark of diſtinction between membranes than their degree of vaſcularity, and particularly in the manner of the diſtribution of their veſſels. The choroid coat is moſt particular in the diſtribution of its arteries and veins. The great arterial vaſcularity of the choroid coat is to be ſeen only after a very minute injection, and the venous vaſcularity after artificial or accidental infarction of the blood, or by a ſucceſsful injection from the ſuperior

cava;

cava; although the very great vaſcularity of this coat was known to our oldeſt writers, yet the appearance of theſe veſſels, when empty, has deceived many. Morgagni * and Maitre-jean, have deſcribed fibres which they affirm to be diſtinct from the veſſels, but which prove to be, in fact, the appearance preſented by the collapſed veſſels.

The great peculiarity of the choroid coat, is its being a ſecreting membrane; by which I mean, that the pigmentum nigrum which is applied to the medullary lamina of the retina being a ſecretion, the choroid coat has neceſſarily that peculiar ſtructure of veſſels which belongs to the ſecreting membrane. This ſtructure has enabled anatomiſts to tear it into laminæ. For that part of the choroid coat next the ſclerotic coat, is merely a vehicle of veſſels and nerves, and is a tiſſue of them connected by very fine cellular membrane. The internal part, again, is organized into a ſecreting ſurface, and is the tunica Ruyſchiana. I conceive, that the diviſion into the choroid coat and tunica Ruyſchiana, is warranted from the nature of the membrane, as the diviſions of the coats of the inteſtines are.

Morgagni ſays, that from his earlieſt youth, he had many proofs that the choroid coat was not ſingle in brutes; he aſſerts, alſo, that Franciſcus Silvius and Guenellonius had demonſtrated the double laminæ of this membrane before Ruyſch †. Certain it is, that Ruyſch was not ſo fortunate in aſcribing a uſe to this

* Morgagni Epiſt. Anat. xvii. 2.

† Idem. ibid. 3.

tunica

tunica Ruyſchiana. He ſuppoſed that it gives ſtrength to the choroid coat, and, by bringing a greater afflux of arterial blood, ſupplies the neceſſary heat to the otherwiſe cold humors *.

TAPETUM. The internal ſurface of the choroid coat has been long called tapetum, from its villous or fleecy appearance, when ſeen through the microſcope. This ſurface in the adult is of a brown colour; in very young ſubjects it is red and bloody; and, when minutely injected, it is like ſcarlet cloth. It is by this vaſcular ſurface or tapetum that the black pigment, which is laid under the expanded retina in the human eye, is ſecreted.

The PIGMENTUM NIGRUM. The pigmentum nigrum is the black or deep brown mucous ſubſtance which lies between the choroid coat and retina. It is of a nature to be waſhed away with a little water and a ſoft pencil †. This brown taint pervades the whole texture

* Quod ad uſum tunicæ Ruyſchianæ attinet crediderim hanc tunicam inter ceteros uſus eſſe deſtinatam, non ſolum ad robur choroideæ, verum etiam ut a ſanguinis arterioſi majori copia requeſitus calor tribus humoribus natura frigidis conciliaretur. Ruyſ. Reſponſ. ad Chriſt. Wedelium, p. 14.

† I cannot conceive how this matter ſhould be confounded with the tapetum or tapis, which, as the name implies, is the villous ſurface of the choroid coat. Tapetum is, properly, cloth wrought with various colours; and the analogy was firſt uſed by the French Academicians, in their account of the diſſection of a lioneſs. "The "membrane which is put into the bottom of the eye, and laid on "the choroides, which we call the tapetum, was of an Iſabella colour, "intermixed with a greeniſh blue. It was eaſily ſeparable from the "choroides, which remained entire, with its ordinary thickneſs, "after

texture of the choroid coat. This matter is in immediate contact with the medullary pulp of the optic nerve. Its uſe is apparently to ſtifle the rays of light after they have impinged on the ſenſible ſurface of the retina; for we know that blackneſs is owing to the abſorption of the light, as whiteneſs and colour is the reflection of it from the ſurface of bodies. The dark colour of the ſecreted pigment of the choroid coat is, in ſome meaſure, peculiar to thoſe animals which ſee in the brighteſt light of day; but is wanting, or of a bright reflecting green or ſilvery whiteneſs, in ſuch as prowl by night. The natural concluſion, therefore, is, that the pigmentum nigrum ſubdues the intenſity of the impreſſion, while the reflecting colours of the ſurface in animals which ſee in the night, ſtrengthens the effect of the light on the ſurface of the retina, by repelling it. As fiſhes have the other proviſions for ſeeing in an obſcure light, they have alſo this of the reflecting ſurface of the tapetum: as it is a ſecretion of the villous ſurface of the choroid, we ſee why it becomes ſomewhat deficient in old men, and ſometimes wanting in the degenerate varieties of animals; when entirely deficient, the blood circulating in the veſſels of the choroid coat gives a livid redneſs to the reflections from the bottom of the eye *.

Finally,

" after that we had taken away the membrane which forms the ta-
" petum." The explanation of this, I ſuppoſe, will be found in Morg. Epiſt. An. xvii. 3.

* As the pigmentum nigrum is a ſecretion, we ſhall not be ſurpriſed to find it become deficient in the commencement of ſome diſeaſes

Finally, in regard to the choroid coat, we have to underſtand that it conſiſts of two laminæ: the outer, and that which is next to the ſclerotic coat, being the proper choroid; the internal lamina, the tunica Ruyſchiana: that on the ſurface of the tunica Ruyſchiana, there is a pile or fleece, which is called tapetum: and, laſtly, that the ſecretion of this inner ſurface is a pigment, which, in the human eye, has the appropriate name of pigmentum nigrum; but, in many animals, it is of a ſilver, golden, or Iſabella colour; though, in my apprehenſion, the colour, in all theſe varieties, depends ſtill upon a peculiar ſecreted matter.

OF THE CILIARY PROCESSES.

The ciliary proceſſes are formed of the anterior margin of the choroid coat; they give the appearance as if the choroid coat, at the anterior part, were folded inward to the margin of the chriſtalline lens; and, as if, to accommodate it to this ſudden inflection, it had been plated, and not regularly contracted; at leaſt, this is much the appearance of the circle of ciliary proceſſes, when, after cutting acroſs the eye, we look from behind upon the lens in its natural ſituation. In this view, we find the pigmentum nigrum of the choroid coat continued over the ciliary proceſſes, which gives

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diſeaſes of the eye. This is known by the poſſibility of ſeeing to the bottom of the eye: that is, the choroid coat becomes a reflecting ſurface, and throws out the beams like a cat's eye. See Med. Obſer. and Enquiries, vol. iii. p. 124.

to

to them the appearance of the regular plicæ of the choroid coat, converging to the edge of the lens, and forming altogether a diſk round it.

When the black paint on the ciliary proceſſes is a little waſhed away, and when we attentively examine this part, we find the ciliary proceſſes to be actually little oblong plicæ, which gradually ariſe from the choroid coat at the angle of its inflection, and terminate abruptly, approximating, but not attached, to the margin of the lens. When the paint is waſhed entirely away, the whole circle of theſe proceſſes appears evidently to be the continued choroid coat.

When not injected, the ciliary proceſſes are pale and looſe; but when minutely injected, they take a perfect ſcarlet colour: they reſemble, in their uninjected ſtate, the valvular-like doublings of the vilous coat of the ſtomach and inteſtines. Before the choroid coat is inflected towards the lens, in the form of ciliary proceſſes, it forms a firm adheſion to the ſclerotic coat near the circular margin of the cornea, and at the ſame time is united firmly to the root of the iris. From this, the proceſſes tend inward, and a little backwards; and are, at their internal extremities, detached from the iris; nor are they attached to the margin of the lens, but are looſe and floating.

When the vitrious humor and lens fall out from the anterior ſegment of the eye, we find that the plicæ or ciliary proceſſes have left their impreſſion on the anterior ſurface of the vitreous humor, and alſo on the intermediate expanſion of the retina which extends before the membrane of the vitreous humor. This circular impreſſion of the ciliary proceſſes is called by Haller,

ſtriæ

ſtriæ retinæ ſubjectæ ligamento ciliari *. I have called this impreſſion HALO SIGNATUS, becauſe it is formed of a circle of radiations, formed by the impreſſion of the ciliary proceſſes, and is not peculiar to the retina, but the retina again makes its impreſſion on the membrane of the vitreous humor. The furrows and doublings of the anterior part of the retina, formed by the impreſſion of the ciliary proceſſes, Dr. Monro has called the ciliary proceſſes of the retina; but, for my part, I think this a term likely to confound and miſlead a ſtudent; and we might as well ſpeak of the ciliary proceſſes of the vitreous humor, or of the membrane of the vitreous humor, ſince they alſo take the impreſſion of the ciliary proceſſes †.

When the vitreous humor and lens are taken out of the coats, we ſee alſo that the ciliary proceſſes have left the ſtain of the fuliginous paint §. This it is neceſſary to remark, ſince I have ſeen ſtudents confound this mark with the ciliary proceſſes themſelves. The ciliary proceſſes are of a moſt elegant vaſcular ſtructure. Their contorted arteries are beautifully repreſented in Zinn's figure. He traces them from the ex-

* Faſcie vii. icon. ocul.

† Winſlow uſes the term ſulci ciliares, for the impreſſion on the vitrious humor. Zinn calls this corona ciliaris, after Camper: he deſcribes them well, p. 75.

§ See Morgagni Epiſt. Anat. xvii. n. 13. and Ruyſch alſo, " Nonnulli pro proceſſu ciliari agnoſcunt pullas pigmenti nigri reliquias, membranulæ tenuiſſimæ humoris chriſtallini & vitrei, & quaſi fibres mentientes oculo ſc. aperto, humoribuſque exemptis; hæ autem nil ſunt niſi avulſæ particulæ pigmenti nigri." Ruyſch. Theſ. An. ii. Aſſ. 1. N° xv.

treme

treme branches of the choroid coat; but, of their veins, he ſays nothing further than that they are continued from the branches of the vaſa vorticoſa, or veins of the choroid coat. The points of the ciliary proceſſes are not attached to the lens, but float looſe in the poſterior chamber of the aqueous humor *; but at a little diſtance from their points, they adhere to the retina, where it is continued over the anterior part of the vitreous humor. Through this attachment only, are they connected with the lens; for, as we ſhall find preſently, the retina (as a membrane, but not as the ſenſible retina) is continued over the chriſtalline lens †.

The ciliary proceſſes, collectively, form a circle round the lens, which I call corona ciliaris. This circle forming a perfectly opaque partition, which ſtifles all rays that might otherwiſe be tranſmitted by the ſide of the lens. The corona ciliaris, or ciliary circle, no doubt, ſerves at the ſame time as a connexion between the outer and ſtrong coats of the eye and the tranſparent coats and humors; for, it is to be obſerved, that, excepting the connexion which naturally exiſts betwixt the optic nerve and retina, this ſlender hold which the ciliary proceſſes take of the expanded retina, is the only attachment betwixt the humors of the eye and the proper coats.

* This was demonſtrated in a particular manner by Ruyſch and Morgagni.

† Zinn and other later writers have entertained the idea, that the adheſion of the ciliary proceſſes to the membranes covering the vitreous humor is by a kind of gluing, rather than a union by cellular membrane. See Zinn, p. 75.

In

In regard to the names appropriated to this part of the eye, there is more confufion than it is poffible to believe. It is neceffary to attend to this ambiguous ufe of terms, elfe we fhall be in danger of mifunderftanding our beft authors. Vefalius confiders the whole as a feptum betwixt the vitreous and pofterior chamber of the aqueous humor; but he feems to find much difficulty in giving it an appropriate name *. Fallopius and Morgagni † ufe the term CORPUS CILIARE for the whole circle of the proceffes, and in the fame fenfe that I have ventured to ufe corona ciliaris. It is a name which conveys the idea neither of the fhape nor of the fubftance of the thing meant. Ruyfch makes great confufion by his ufe of terms; the corona ciliaris, or ciliary body, he calls the ligamentum ciliare; and the lines on the back furface of the iris, he calls proceffus ciliaris mufculofus; or, rather, he means by this, the ftraight fibres of the iris ‡. Duverney, with Ruyfch and Winflow, following Fallopius, calls the corona ciliaris alfo ligamentum ciliare. But the ciliary li-

* "Neque mihi ullum occurrit nomen quod ipfi aptius indam "quam tunicæ: aut fi voles, interftitii vel fepti inter vitreum "humorem & eum quem albugineum nuncubamus repofiti." Vefal. vol. i. p. 558.

† Epift. Anat. xvii. 11.

‡ Ruyfch has this expreffion; "Ligamentum ciliare neutiquam effe confiderandum tanquam mufculum ad pupillæ et humoris criftallini motum deftinatum, totumque hoc negotium perfici a proceffu ciliari ut et a circulo mufculari pofterius in confinio pupillæ fito." Thes. Anat. ii. xv. See alfo the explanation of fig. iv. of this Thefaurus, where we have "Iris enim eft facies exterior, proceffus lig. ciliaris facies interior.

gament is ufed by others in a widely different fenfe, viz. for the circular root of the ciliary body and iris, the anulum album cellulofum, or the frenula membranofa of Zinn. By Hovius, what I have called halo fignatus, is called ligamentum ciliare. In Haller's fifth figure of the eye, this circular root of the ciliary proceffes, is called orbiculus ciliaris. Maitre-jean, Haller, and others, call the whole body, or corona, the ciliary circle. M. Ferrein, Lanneau de la Choroide, and M. Lieutaud, denominated the ciliary proceffes "rayons "ciliares," and the root of the corona ciliaris and iris, "plexus ciliaris."

CHAP. III.

OF THE IRIS.

THE iris is the coloured circle which ſurrounds the pupil, and which we ſee through the tranſparent cornea of the eye. It is a membrane hung before the criſtalline lens *. It is as if perforated in the middle; and this hole in the middle of the iris is the pupil; and through the pupil only can the rays be tranſmitted to the bottom of the eye. When we hear of the dilatation and contraction of the pupil, we have to underſtand the action of the iris, which, by poſſeſſing the power of contracting and relaxing, holds a controul over the quantity of light tranſmitted to the bottom of the eye. For by the extenſion of this membrane, the diameter of the pupil is diminiſhed, and, by contraction of the membrane, it is dilated. This motion of the iris, and, conſequently, the ſize of the pupil, is connected with the ſenſation of the retina; by which

* Winſlow and Haller, and moſt of the old anatomiſts, call this UVEA; but moſt of the modern anatomiſts follow *Zinn* and Lieutaud, in calling it iris; though Lieutaud and others called the anterior ſurface only iris, while they ſtill continued to call this perforated membrane choroides, or uvea. See Lieut. p. 117. Again, others call the poſterior ſurface of the iris uvea, from its likeneſs to the dark colour of a raiſin; and the word iris is borrowed, I ſuppoſe, from the varied colours of the rainbow.

means, in diſeaſe of internal parts of the eye, it is often an index to us of the ſtate of the nerve, and of the poſſibility of giving relief by operation.

The iris and corona ciliaris, or ciliary proceſſes, are, in general, conſidered as being the two laminæ of the choroid coat continued forward and ſplit: The internal lamina of the choroid forming the corona ciliaris, and the outer one forming the iris. The former I was willing to conſider as the anterior margin of the choroid coat, becauſe it has no diſtinction in its ſtructure from that coat; but the iris I cannot conſider as the continued choroid coat: in the *firſt* place, becauſe I have found it fall out a perfect circle by maceration; *ſecondly*, becauſe it has no reſemblance in ſtructure to the choroid coat; and, *chiefly*, as by its power of contracting, it ſhows a widely different character from any of the other membranes of the eye.

The outer ſurface of this circular membrane gives the colour to the eye during life; and from its beautiful and variegated colours, it has gained to the whole membrane the name of iris. Haller and Zinn, nearly at the ſame time, explained the cauſe of this coloured iris, which had been, till then, ſuppoſed to be occaſioned by the refraction of the light amongſt its ſtriæ and fibres.

When this membrane is put in water, and examined with the microſcope, its anterior ſurface is ſeen to be covered with minute villi. The ſplendid colouring of the iris proceeds from the villi; but by beginning putrefaction, the ſplendid reflection fades, as the brilliant ſurface of the choroid of brutes is loſt by keeping. For this reaſon, I imagine the colour and brilliancy of the

the iris to depend on the ſecretion of theſe villi. But the colour of the iris depends, in a great meaſure, on the black paint upon its poſterior ſurface ſhining through it; and the black and hazzel-coloured iris is owing to the greater degree of tranſparency of the iris, which allows the dark uvea to ſhine through it.

The iris is acknowledged to be the moſt acutely ſenſible part in the body. We have, then, to expect in its compoſition, muſcular fibres, and to account for its acute irritability and ſympathy, by a profuſion of nerves: again, as the power of the muſcular fibre, and the ſenſibility of the nerve, are both, in ſome meaſure, indebted to the circulation of the blood, we may expect to find alſo a profuſion of veſſels in the iris. In all theſe reſpects, we ſhall find the iris to be an object of admiration.

OF THE MUSCULAR FIBRES OF THE IRIS.

It is evident from a note, under the head corona ciliaris, that Ruyſch had obſerved two ſets of muſcular fibres in the iris; for, under the name of ciliary ligament, he deſcribes a ſet of radiated fibres which go from the ciliary proceſſes towards the circular margin of the pupil: he obſerved alſo, the circular or orbicular fibres which run round the margin of the pupil: Winſlow ſays, that between the two laminæ of the uvea (viz. iris) we find two thin planes of fibres, which appear to be fleſhy: the fibres of one plane orbicular, and lying round the circumference of the pupil, and thoſe of the other being radiated; one extremity of it being fixed to the orbicular plane, the other to the

 great

great edge of the uvea. Zinn defcribes, with much minutenefs, radiated fibres (on the anterior furface of the iris), but does not confider thefe as mufcular fibres; and he confeffes, that he could not obferve the orbicular mufcle which Maitre-jean and Ruyfch had painted. Even in owls and other creatures, having a ftrong iris, he could not difcover an orbicular mufcle; nor were Haller and Morgagni more fuccefsful in this invefti-gation *. Wrifberg alfo affirms, that no mufcular fibres could be feen in the iris of the ox. Dr. Monro, on the other hand, adheres to the opinion of the mufcu-larity of the iris: he defcribes minutely both the radi-ated and fphincter fibres. Wrifberg and others have thought they found fufficient proof againft the mufcu-larity of the iris, in the fact of its not contracting when the light falls upon its furface. To this Dr. Monro anfwers, that the colour or paint upon the iris muft, like a cuticle, prevent the light from irritating the iris. I cannot think that this circumftance fhould prevent the excitement of the iris. The retina is in a peculiar manner fufceptible of the impreffion of light; but we cannot wonder that light fhould not ftimulate a mufcle to contraction, when we have every proof that it has no effect on the moft delicate expanded nerve of the other fenfes.

That the iris is to be affected only through the fen-fation of the retina, or perhaps rather the effect com-municated to the fenforium, we have fufficient proof.

* See Zinn, p. 89 and 90. Morgagni. Epift. Anat. xvii. § 4. Haller and Ferrein attribute the motion of the iris to an afflux of humors in its veffels.

I have,

I have, in couching, repeatedly rubbed the ſide of the needle againſt the iris without exciting any motion in it: I have ſeen it pricked ſlightly by the needle without its ſhowing any ſign of being irritated; nay, what was too a convincing proof, I have ſeen it cut by falling before the knife in extracting the cataract: In this laſt inſtance, far from being ſtimulated to contraction, it hung relaxed *.

It is evident, then, that no common ſtimulus, immediately applied to the iris, has any ſenſible effect in exciting it to contraction; and that it is ſubject only, in a ſecondary way, to the degree of intenſity of light admitted to the retina. The movement of the iris is in general involuntary; but terror and ſudden fright affect it. In ſome animals, particularly in the parrot, it is a voluntary muſcle †. As an object, upon which we look, approaches the eye, the pupil contracts, which is an effect of the increaſing intenſity of the light reflected from the object; for, as the object ad-

* This fact deſtroys the hypotheſis of M. Mery, of the Royal Acad. of Sciences, that the ſtraight fibres of the iris are little cavernous bodies, and that the action of the light upon the retina ſwelled and elongated them ſo as to cauſe the diminution of the ſize of the pupil; for, by this cut, they muſt have fallen from their erected ſtate, and contracted ſo as to have dilated the pupil. See Acad. Roy. des Sc. 1704, mem. p. 261.

† When a cat is rouſed to attention, as by the ſcratching of a mouſe, it dilates the pupil, which allows a ſtronger impreſſion on the bottom of the eye; nay, whenever puſs ſtruggles violently to get looſe, the pupil dilates, which may ſufficiently account for M. Mery's cat having her pupil dilated when he plunged her under the water. See Acad. Roy. des Sc. 1704, mem. 261.

vances, it fills a greater ſpace in the ſphere of viſion, and of courſe more rays flow from it into the eye.

Nerves of the iris. The iris is ſupplied with nerves in great profuſion. They are derived from the long ciliary nerves which run forward betwixt the cornea and choroid coat towards the common root of the corona ciliaris and the iris. They there divide, and are ſeen to paſs in numerous branches into the ſubſtance of the iris. In the ſubſtance of the iris, the branches of the nerves, from their extreme minuteneſs, are ſoon loſt amongſt its pale fibres.

Blood vessels of the iris. I have had preparations which ſhowed ſo great a degree of vaſcularity in the iris, that I was ready to believe its action to be produced entirely by a vaſcular ſtructure; but when, on other occaſions, my admiration was excited by the profuſion of nerves, and I was led to obſerve that in the former inſtances they had been obſcured by the injection, I could not but allow that the muſcular fibres might have been obſcured as the nerves were.

There are four arteries ſent to the iris: two long ciliary arteries which take a long courſe on the outſide of the choroid coat, and two leſſer and anterior arteries which pierce the ligamentum ciliare from without. Theſe arteries approach the root of the iris at four oppoſite points, and branching widely form a vaſcular circle round the root of the iris, viz. the larger circle of the iris. From this circle branches paſs off, which run with a ſerpentine courſe, converging to the edge of the iris: here they again throw out inoſculating branches, which form a circle ſurrounding the pupil, but at ſome

little

little diſtance from the edge of the iris—this is the leſſer circle of the iris. From this leſſer circle there again proceed minute branches towards the edge of the iris *.

The VEINS, which intermingle their branches with theſe arteries, paſs ſome of them into the vaſa vorticoſa of the choroid coat, and others take a long courſe betwixt the choroid and ſclerotic coat, accompanying the ciliary nerves, whilſt ſome branches pierce the ſclerotic coat at the root of the iris, and become ſuperficial upon the fore part of the eye.

* See Ruyſch Epiſt. Anat. prob. xiii. p. 31.

CHAP. IV.

PRACTICAL REMARKS DEDUCED FROM THE STRUCTURE OF THE CHOROID COAT AND IRIS.

THE choroid coat, ciliary proceffes, and iris, being the moft vafcular parts of the eye, are frequently the feat of difeafe, and adminifter to the diforder in all violent internal affections of the organ. I had always conceived thefe parts to be chiefly active in the carcinoma of the bulb of the eye, and I had lately an opportunity of obferving this in diffection. In this difeafe, there is firft deep pain in the eye, from the inflammation and diforder of the vafcular coats; and often the effect of the increafed action, within the eye, is known from its effects in enlarging the veins on the furface of the eye-ball. Thefe veffels being active in their natural ftate, are very apt to become difeafed when difturbed in their action; and although we frequently fee the eye quite funk, yet, when it is burft, and the vafcular coats are protuberant, a cancerous ftate of the eye is to be dreaded.

When the eye is hurt by a blow; when inflammation fpreads from the cornea to the iris, in confequence of a fmall-pox puftule; when an ulcer of the cornea, or an incifion of it does not heal quickly, but allows the aqueous humor to diftil out, and con-

fequently

ſequently the iris to fall in contact with the cornea; the iris adheres, and often forms ſtaphyloma. Thus we find ſtaphyloma to follow the operation of extraction, in conſequence of the iris protruding and adhering to the wound: again, in ſtaphyloma from ſmall-pox, by the adheſion of the iris to the cornea, while the cornea is extending and perhaps burſts, the iris mixes with the cornea, and gives the ugly black and mixed colours of this diſeaſe. I have a preparation in which the cornea had greatly dilated; the iris is extended like a black net-work upon the inner ſurface of the cornea; and in the uſual place of the iris, the ciliary proceſſes are to be ſeen. The iris adheres alſo to the capſule of the lens, which is behind it, and, as we ſhall preſently ſee, cloſe upon it. I ſaw it in one inſtance, adhering ſo ſtrongly to the cataract, that, in attempting to depreſs the cataract with the needle, the edge of the iris was turned over and depreſſed with the needle, and the regularity of the pupil was deſtroyed; of courſe, here, there could be no permanent depreſſion, without previouſly cutting this adheſion.

It was at one time believed, on the authority of many excellent anatomiſts, that the veſſels of the iris were colourleſs, and did not circulate red blood: after what has been ſaid, it is ſcarcely neceſſary to mention the fallacy of this opinion *. I have ſeen the iris cut and bleeding, though not profuſely as I expected;

* Dr. Monro, in treating of this ſubject, mentions his having ſeen a net-work of veſſels covered with paint darker than that of the iris, and extended from the iris upon the ſurface of the lens; and, in another inſtance, a net-work of filaments paſſing quite acroſs the pupil. See his Diſſertations, p. 108.

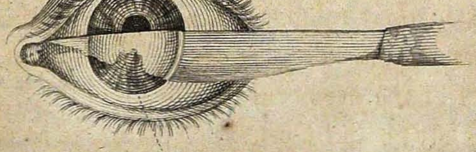
pected; the ſmall quantity of blood ſoon coagulated into a dark ſpeck, while I expected it ſhould have been effuſed in the aqueous humor.

There is a circumſtance in the operation of extracting the cataract which I have ſeen little attended to, and yet it is ſufficiently evident. When the cornea has been cut, operators, diſappointed in not finding the cataract protruded, keep the eye ſtaring in the light, and preſs the ball of the eye; but while the eye is thus expoſed to the excitement of the light, the pupil is contracted, and the lens propelled by the action of the muſcles; and, ſtill more, by the preſſure made on the eye-ball, is in danger of burſting through and tearing the iris. The beſt operators have been in the cuſtom of ſhutting the eye-lids the inſtant the inciſion was made in the cornea; by this means, the eye is for a time ſupported in ſome degree during the violent ſpaſm of the recti muſcles, and the iris being allowed to dilate, the lens is protruded into the anterior chamber of the aqueous humor through the pupil, and is ready to ſlip from under the cut cornea, when the eye-lids are again opened. By this means, if the inciſion of the cornea is of the proper extent, the lens is not *extracted*, but is *protruded*, by the action of the muſcles of the eye.

It is very neceſſary for us to remember, that all the parts of the eye in themſelves extremely delicate, are kept in their relative places, not by adheſions, but by the complete ſupport they derive from the globular form of the eye, and by the ſtrength of the outer coat or ſclerotic and cornea. To this, it is particularly neceſſary to attend, in the operation of the extraction of the

the cataract; for, as ſoon as the aqueous humor is evacuated, the uniform reſiſtance of the coats of the eye is deſtroyed, and the muſcles ſurrounding the eye-ball force all the humors towards the inciſion. It is this circumſtance which brings the iris into great danger of being cut when the knife is too narrow to make the inciſion, at once, by puſhing it through the cornea with an uninterrupted motion of the fingers. For, when the knife is not broad enough to cut itſelf out by moving it uniformly along, the aqueous humor eſcapes in the endeavour to cut downwards, and the iris is protruded ſo as to fall under the edge of the knife; nay, with a good knife, and of a ſhape to cut itſelf out, and at the ſame time adapted to make a cut in the cornea ſufficient to allow the eſcape of the lens, I have ſeen, in conſequence of a heſitating manner of introducing the knife, the aqueous humor ſuffered to eſcape. Now, obſerve the conſequence of this:—The lens being puſhed outwards by the contraction of the muſcles on the eye-ball, towards that point at which the continuity and conſequent uniform reſiſtance of the coats were broken, the margin of the iris was forced under the edge of the knife and cut, as I have here repreſented.

Fig. 12.



A very

A very particular effect of this cut upon the margin of the iris is to be obſerved—When the inciſion has been happily done, the lens is protruded uniformly through the pupil; but when the iris was cut, as now explained, the edge of the lens, oppoſite to the part of the iris which was cut, was forced forward; the lens was turned ſide-ways, without being entirely diſplaced; and a great part of the vitreous humor was allowed to eſcape.

CHAP. V.

OF THE RETINA, AND DIGRESSION CONCERNING THE SEAT OF VISION.

THE term retina has, in a modern publication, been objected to, as improperly applied to the inner coat of the eye. Such a term, it has been ſaid, may well be applied to the nerve expanded on the lamina ſpiralis of the cochlea, becauſe it is there formed into an intricate plexus by innumerable joinings and ſeparations of its component parts; but uſed for the expanded nerve of the eye, the term retina is thought improper *. We muſt look for the reſemblance, however, which juſtifies this term, not in the medullary matter of the nerve, but in its veſſels. " Hanc figuram egregie re-" præſentat dicta tunica retina cum arteriolæ ceracea " materia ſunt repletæ †."

The retina is the expanſion of the optic nerve; the immediate ſeat of ſenſation, and the moſt internal of thoſe membranes which are called the coats of the eye. It has been already obſerved, that there is a diſtinction betwixt a nerve in its courſe from the brain to the organ of ſenſe, and where it is actually expanded and adapted to the reception of the external impreſſion. Before the optic nerve has perforated the ſclerotic coat

* Dr. Monro's 4to Treatiſes.

† Ruyſch. Epiſt. Anat. xiii. p. 14. Quemobrem ſervare adhuc retinæ, appellationem ſi non ex fibrarum ut certe ex vaſorum implicatione, &c. Morgagni Epiſt. Anat. xvii. § 43.

of

of the eye, it is furrounded with a firm fheath; and its fubftance is evidently compofed of bundles of fibres, though not fo coarfe, yet like thofe of the nerves in the other parts of the body. The opacity of the nerve makes it have little the appearance of vafcularity, but when the body of the nerve is made tranfparent, it becomes like a red cord; fo neceffary is it that the medullary fubftance of the nerve be fupplied with blood.

The ftronger fheath which furrounds the body of the optic nerve is loofe, and may be feparated into lamellæ. There is a more delicate membrane which immediately adheres to the furface of the nerve; and its fubftance is formed into the minute fafciculi which give it the fibrous appearance by a ftill firmer intertexture of membrane. This interwoven membrane proceeds, with the retina, into the eye; the other fheaths are reflected off, and unite with the fclerotic coat. Some little way from the back part of the eye, the arteria centralis retinæ pierces the fheath of the nerve, plunges into the centre, and paffes into the eye along with it. If the optic nerve be cut near to the eye, the open mouth of this fmall artery may be feen; but if we make our fection fome way removed from the back of the eye, it will, of courfe, not be feen. The artery contracting and leaving a fpace in the centre of the nerve when thus cut, (or perhaps it was the open mouth of the artery itfelf), was obferved by the ancients, and by them called the porus opticus, becaufe they were ignorant of this central artery of the retina *.

* Porum opticum Herophilus et omnis ab ea antiquitas dixit, foramen nempe quod in diffecto nervo de vacua arteria fupereft. Hall. Arter. Ocul. Hift. p. 42.

Where the optic nerve is about to enter into the ball of the eye, it is much diminiſhed in diameter; it is contracted and condenſed, and, at the ſame time, lays aſide the ſtrong coats. The proper nerve then perforates a cribriform lamina in the ſclerotic coat. Within the eye, the filaments ſeen in the nerve are no longer diſtinguiſhable; but from the extremity of the nerve the fine web of the retina is produced.

The LAMINA CRIBROSA, and the delicate faſciculi of the optic nerve, are ſhown in this manner: After making a ſection of the eye, waſh away the retina from the extremity of the optic nerve, and alſo the choroid coat; then preſs the optic nerve betwixt the finger and thumb, when the pulp of the nerve will be ſeen to protrude through the foramina in the ſclerotic coat like white points. It is obſerved by Zinn, that, in doing this, there is a central foramen which remains unfilled up by the compreſſion of the nerve. This is the hole perforated by the arteria centralis retinæ *. Where the threads of nerves are accumulated after paſſing theſe foramina, and before they are finally expanded into the retina, they neceſſarily form a ſmall cone or papilla. This conical form of the extremity of the optic nerve is much more evident in ſome animals than in others; but in a ſection of the human optic nerve we may alſo obſerve it †.

* Zinn de oculo humano, p. 106. Com. Reg. Soc. Scient. Gotting. loc. cit. About 30 foramina have been obſerved in the lamina cribroſa. See Haller Faſc. de Arter. Oculi, p. 42.

† Zinn. " At the place which anſwers to the inſertion of the " optic nerve, we obſerve a ſmall depreſſion, in which lies a ſort of " medullary button terminating in a point." Winſlow, p. 78.

The retina is a membrane of the moſt delicate texture of any in the animal body: it is tranſparent in the recent ſtate, and ſo ſoft, that it will tear with its own weight. In ſpirits and weak acids, it becomes opaque and firmer. It lies expanded over the vitreous humor, and contiguous, but not adhering, to the choroid coat, or its pigment. The retina does not conſiſt merely of the expanded nervous matter, but has, in its compoſition, a very fine membrane, and many minute veſſels. When the retina is macerated for a conſiderable time, the pulp of the nerve can be waſhed away, and there remains only the reticulated and delicate membrane which ſupports the veſſels that nouriſh it. But though the pulp of the nerve may be diſſolved, it cannot, by diſſection, be freed from the membrane which ſupports it *.

I have a preparation which more reſembles ſome of Ruyſch's plates than any I have ſeen. In this preparation, the nerve being waſhed away, we may ſee diſtinctly the whole courſe of the arteria centralis retinæ. Of this preparation I have given an engraving, to ſhow how plentifully this organ is ſupplied with red blood; from which circumſtance we may learn the ſtrict de-

* "Poſſe vere medullarem retinæ laminam removeri ut vaſculoſum rete membranæ figuram retineat, alteramque ab altera integram detrahi ultra hominum artem poſitum eſſe videtur nec ulli unquam contigiſſe, legere me memini, etſi, deleta macerendo medulla, rete vaſculoſum laminam peculiarem referre videatur. Ex quibus omnibus elicio retinam eſſe tunicam ſimplicem, ex celluloſa conflatam: que vaſcula et ſubſtantiam medullarem ſuſtinet etſi duas diverſas oſtendat facies alteram vaſculoſam interiorem, alteram medullarem exteriorem." Zinn, p. 112.

pendence

pendence of its function on the circulation, and deduce the derangement of the powers of vifion, as a natural confequence of the difordered action of thefe veffels.

The foft medullary matter of the retina is towards the furface of the choroid coat, and forms there a lamina, which appears to me to be the furface of the nerve upon which the rays of light impinge *. The veffels of the retina run upon the furface contiguous to the vitrious humor †. The arteria centralis retinæ is derived from the opthalmic artery. It pierces the optic nerve, as we have already obferved, and enters the eye through the porus opticus, to fupply the retina. But the arteries of the retina do not always enter into the eye in one trunk; on the contrary, fometimes two or three branches pierce the lamina cribrofa ‡, and afterwards, two, three, or four principal branches,

* "C'eft fur-tout dans les poiffons qu'il eft facile de diftinguer et "meme de feparer ces deux lames." Cuvier, tom. ii. p. 419.

The opacity of the outer furface of the retina prevents the vafcularity from being apparent. Albinus, after a very minute injection, obferved, that when he lifted up the choroid coat, the vafcularity of the retina was not feen: "Autem de ea aliquid acuto fcalpello fubtiliter leviffimeque deradens, mox confpicio vafa impleta multa "quæ fub medulla cujus nimirum portionem deraferam latuerant." Albin. An. Acad. lib. iii. cap. xiv.

† Dr. Monro has thefe words, expreffive of an oppofite opinion: "The whole appears to be compofed of an uniform pulpy matter, on the outer fide of which chiefly veffels are difperfed, fupported, I fuppofe, by a membrane the fame or analogous to the pia mater." 4to Treatifes on the eye, ear, &c.

‡ Haller loc. cit. Morgagni Ep. Anat. xvii. n. 44. nor do they always pierce the centre of the nerve exactly. Morgagni.

 fpread

ſpread out on the circumference of the retina; from theſe, the ramifications are ſo numerous, that Ruyſch deſcribes them as conſtituting the membrane *. Correſponding with the arteria centralis retinæ in the adult, there are veins, the minute extremities of which, after forming connections with the veins of the corona ciliaris, run backwards on the inner ſurface of the retina in three or four diſtinct branches. Theſe uniting into a trunk, perforate the lamina cribroſa, and become the ſocia arteriæ centralis.

Many have been led to believe, that the retina terminates forward on the roots of the ciliary proceſſes, as others have conceived it to be continued over the fore part of the vitreous humor, and over the ſurface of the lens †; but the moſt prevalent opinion is, that it terminates on the margin of the lens.

That the retina extends over the back of the lens, and receives there the impreſſion of light, is very improbable; but that the membrane which ſupports the retina, is continued over the lens, is demonſtrable. As I have juſt ſaid, the retina, I conceive (with Albinus, M. Ferrein, and others), to conſiſt of

* "Iteratis perſcrutiniis reperio oculis armatis arteriolarum extrema tam eſſe numeroſa & tam arcte ſibi invicem et intricate annexa ut peculiarem repreſentent membranulam ex arteriolarum extremis conſtitutam, cui connectetur dicta medulloſa ſubſtantia." Ruyſch Epiſt. Anat. xiii. p. 15.

† Many anatomiſts, Winſlow, Caſſobohm, Ferrein, Lieutaud, and Haller, have taught that the retina extends over the great convexity of the lens, or that it is inſerted into it. Galen believed it to extend over the lens. For an impartial hiſtory of opinions, ſee Morgagni Epiſt. Anat. xvii. 47. and Zinn, 114.

2 two

two diſtinct parts, viz. the medulla of the nerve, and a pellucid membrane ſupporting it; but, however reaſonable this concluſion is, I cannot believe that theſe portions are to be ſeparated by diſſection. It is, by moſt anatomiſts, believed, that the retina paſſes forward betwixt the vitreous humor and ciliary body, and adheres to the margin of the lens. Now, as this adheſion is not a glueing together of parts, but a union or intermixture of membranous filaments, the interchange and mingling of fibres, we may ſafely ſay, that the membrane of the retina is continued over the lens, and forms part of its capſule. The opacity of the retina is diminiſhed at the root of the ciliary proceſſes, and diſappears altogether at the margin of the lens; and here it is not only changed by becoming perfectly tranſparent and allied to the membranes of the humors, but it becomes alſo diſtinguiſhable from the opaque retina by a greater toughneſs and ſtrength. The continuity of the retina with the capſule of the lens is more apparent, when both membranes have become opaque by being immerſed in ſpirits or vinegar, but more particularly when that opacity is produced by diſeaſe. In diſeaſe, I have found the veins of the retina running over the margin of the lens, and branching on its poſterior convexity.

Where the retina lies betwixt the vitreous humor and the ciliary proceſſes, it is plaited, and deſcends into the interſtices of theſe proceſſes.

When we take off the ſclerotic and choroid coats of the eye, by diſſecting them round the inſertion of the optic nerve, and fold them back, carefully preſerving the retina; and when we have taken away the ciliary

processes from their adhesion, to the fore part of the retina, we find the retina to form a sac surrounding the vitreous humor, and supporting the lens. In all this surface, the membrane is smooth and uninterrupted. To the margin of the lens all this sac is opaque; because, upon the outside of the retina, is the opaque pulpy nervous matter, but the coats of the lens are transparent, yet continuous with the arachnoid portion of the retina. When these parts of the eye are thus dissected, they hang all together by the optic nerve; viz. the lens, the vitreous humor, and the expanded matter of the nerve being supported by delicate and pellucid membranes, constituting part of the retina; and the organ, is divested only of its outer apparatus; we still retain within this the more essential and important parts.

There is here a natural division; and I am willing to pause upon this, knowing well with how much difficulty the student gains a knowledge of the minute structure of the eye, when point follows upon point of the detail, without any resting-place or mark of division and character. All within the connexions of the retina, I shall call the INTERNAL GLOBE of the eye, as distinguishing it from the outward coats of the eye and parts subservient to them. A view of the little vascular system of these internal parts, thus classed, will show how strictly they are connected together, and how much insulated from the other parts.

But this is a subject upon which we cannot venture, until we have considered the nature and relative situation of the humors of the eye.

DIGRESSION ON THE SEAT OF VISION.

M. L'Abbe Mariotte discovered the curious fact, that when the rays fall upon the centre of the optic nerve, they give no sensation. He describes his experiment in this manner:—"Having often observed, in dissections of men as well as of brutes, that the optic nerve does never answer just to the middle of the bottom of the eye; that is, to the place where the picture of the object we look directly upon is made; and that, in man, it is somewhat higher, and on the side towards the nose; to make, therefore, the rays of an object to fall upon the optic nerve of my eye, and to find the consequence thereof I made this experiment. I fastened on an obscure wall, about the height of my eye, a small round paper, to serve me for a fixed point of vision; I fastened such another on the side thereof towards my right hand, at the distance of about two feet, but somewhat lower than the first, to the end that I might strike the optic nerve of my right eye while I kept my left shut. Then I placed myself over against the first paper and drew back by little and little, keeping my right eye fixed and very steady upon the same, and being about ten feet distant, the second paper totally disappeared *."

This defect in the vision of the one eye is corrected by that of the other; for the insertion of the optic nerves being towards the side next the nose, no part of an image can ever fall on the optic nerve of both eyes

* Vid. Phil. Transf. No. 35. Smith's Optics, Remarks on art. 87.

at once. The effect of viſion, therefore, is obſerved only in very careful experiments. Experiments were, however, made by M. Picard, Marriotte, and Le Cat, to render this effect produced by the image falling on the centre of the optic nerve evident, when looking with both eyes. Marriotte's ſecond experiment was this: Place two round pieces of paper at the right of your eyes, three feet from one another, then place yourſelf oppoſite to them at the diſtance of 12 or 13 feet, and hold your thumb before your eyes at the diſtance of about eight inches, ſo that it may conceal from the right eye the paper that is to the left hand, and from the left eye the paper to the right hand. If, now, you look at your thumb ſteadily with both eyes, you will loſe ſight of both the papers *. The novelty of ſuch a diſcovery was likely, as frequently is the caſe, to carry mens minds beyond the true point. It requires time for ſuch facts to deſcend to their level, in the ſcale of importance, with other leſs novel obſervations. Marriotte, upon this fact, formed a new hypotheſis relating to the ſeat of viſion. We have obſerved, that the choroid coat and pigmentum nigrum are deficient, where the optic nerve enters the eye, and is about to expand into the retina. He fixed upon the moſt unaccountable ſuppoſition, that the retina does

* Dr. Smith made the ſtream of light through the key-hole of a dark chamber fall upon this point of the retina, oppoſite to the termination of the optic nerve, but he found it quite inſenſible even to this degree of light. M. Picquet aſſerts, that very luminous objects make a faint impreſſion on the centre of the optic nerve. But Dr. Prieſtley ſays, that a candle makes no impreſſion on that part of his eye.

not

not receive the impreſſion of the rays, but that the choroid coat is the ſeat of the ſenſe. In ſupport of this theory, he ſoon found other arguments than thoſe ariſing from the deficiency of the choroid coat at the entrance of the nerve. He ſaw that the pupil dilated in the ſhade, and contracted in a more intenſe light: now, ſays he, as the iris is a continuation of the choroid coat, this is a proof of the great ſenſibility of that coat: again, the dark colour of the choroid coat he ſuppoſed to be well calculated for the action of the rays of light, which are not reflected from it or tranſmitted, but abſorbed; while, on the other hand, the retina is tranſparent. If viſion were performed in the retina, ſays Marriotte, it ſeems that it ſhould be found whereever the retina is; and ſince the retina covers the whole nerve as well as the reſt of the bottom of the eye, there appears no reaſon why there ſhould be no viſion in the place of the optic nerve. M. Picquet argued in oppoſition to Marriotte. He obſerved, in regard to the fitneſs of the black colour of the choroides for the action of the rays of light, that the choroid is not univerſally black; that there are many ſhades of difference in the human eye; and that it is black, blue, green, yellow, or of a metallic ſhining ſurface, in a variety of animals. He conceived, that the defect of viſion at the inſertion of the nerve is occaſioned by the blood-veſſels of the retina *. He obſerved, alſo, that the opacity of the

* Againſt this hypotheſis, the ſize of the inſenſible ſpot was urged by Marriotte. Bernuoilli calculated that this ſpot is a circle, the diameter of which is a ſeventh part of the diameter of the eye, and that the centre is 27 parts of its diameter, from the point oppoſite to the pupil and a little above the middle.

retina

retina is ſuch, as neceſſarily to obſtruct the tranſmiſſion of the rays of light to the choroid coat. M. de la Hire took part in this controverſy. He conſidered the retina as the organ of ſight, although a particular point of it is not ſuſceptible of immediate impreſſions from outward objects; for, ſays he, we muſt not conceive ſenſation to be conveyed by any other means than by the nerves. But, obſerving the conſtitution of the other organ of the ſenſes, he entertained an idea that the retina receives the impreſſion in a ſecondary way, and through the choroides, as an intermediate organ; that, by the light ſtriking the choroid coat, it is agitated, and communicates the motion to the retina; and we find that, through all the organs of the ſenſes, he continues, the nerves are too delicate to be immediately expoſed to the naked impreſſions of external bodies.

Another objection to the opinion, that the retina is the ſeat of ſenſation, has been lately urged, viz. that the thickneſs of this coat, together with its tranſparency, allows of no particular ſurface for receiving the image; and that its tranſparency would cauſe a partial diſperſion, which would produce a confuſion in viſion *.

If theſe opinions require ſerious refutation, we have it in the effects of the diſeaſes of the retina, optic nerve,

* M. Le Cat thought that the pia mater was the ſentient part of the nerve. It was, therefore, a kind of confirmation of his opinion to ſuppoſe the choroid to be the ſeat of viſion, as he teaches that the choroid coat is a production of the pia mater. He conceived that the retina moderated the impreſſion of light upon the choroid coat, as the cuticle dulls the impreſſion on the papillæ of the tongue,

and

Fig. 1.

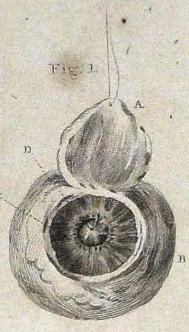


Fig. 2.

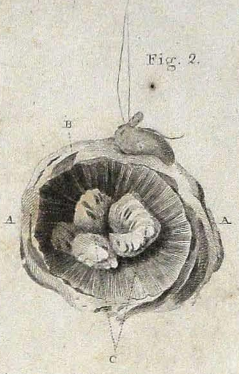


Fig. 3.

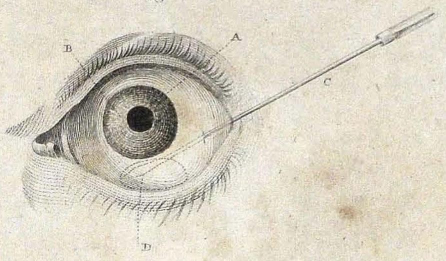


Fig. 4.

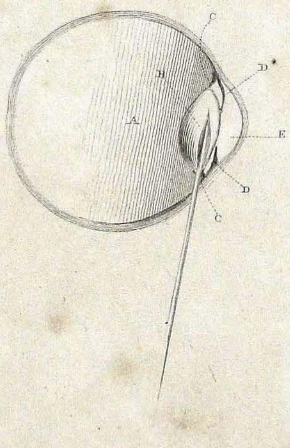
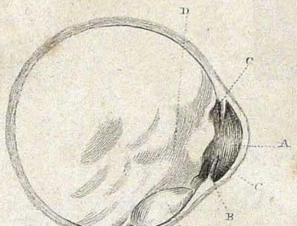


Fig. 5.



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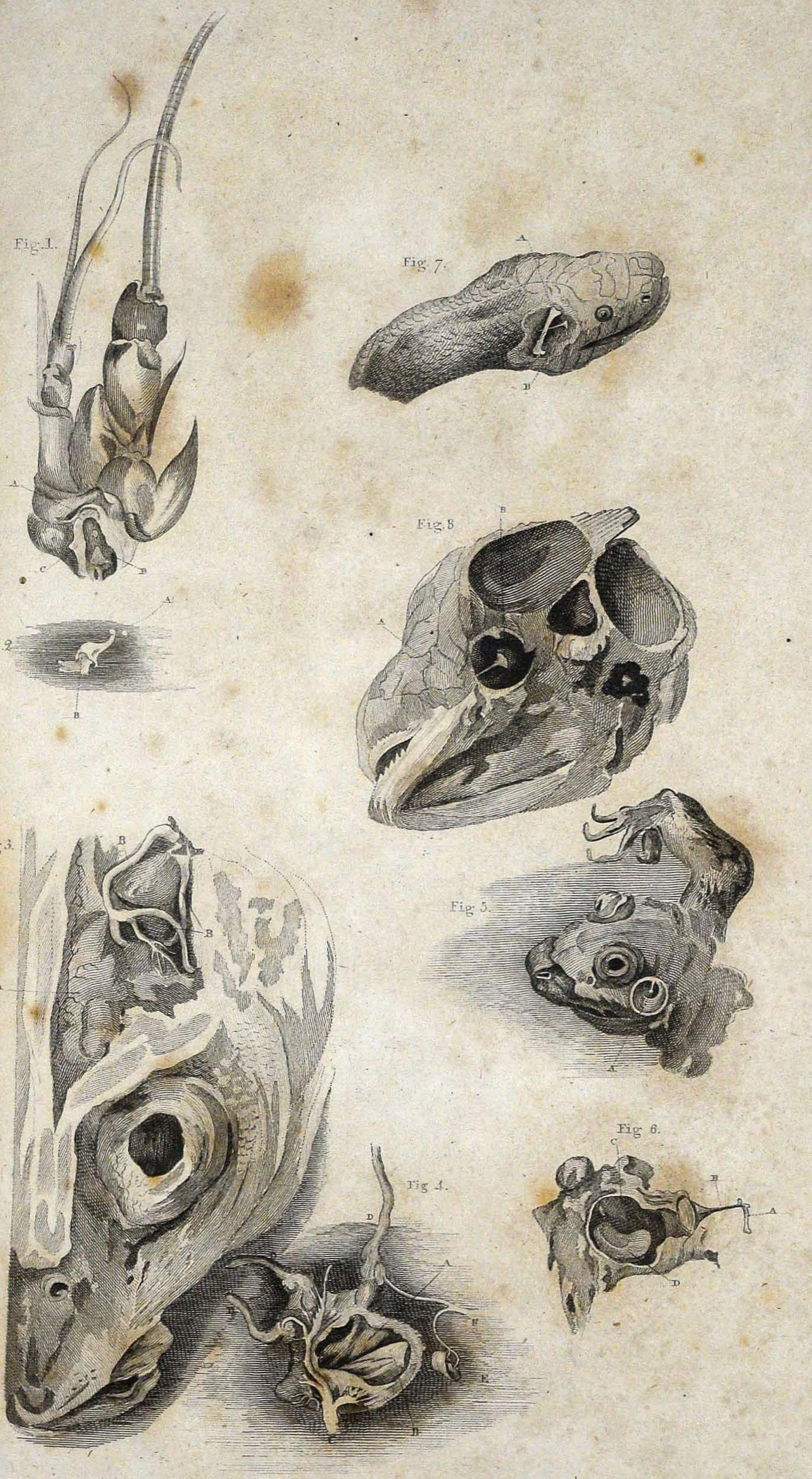

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Plate IX

Fig. 2.

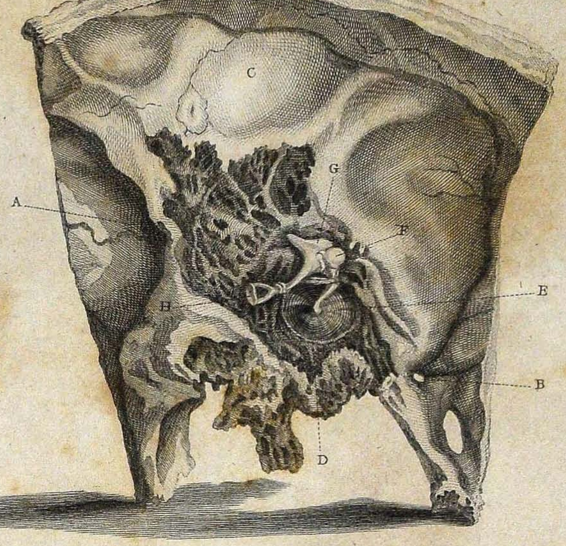

Fig. 1.

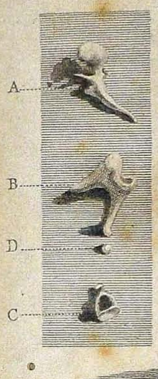

Fig. 4.

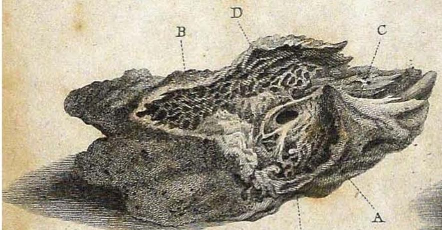

Fig. 3.

Fig. 5.

Fig. 6.

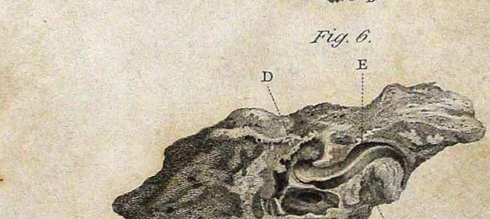

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Fig. 1.

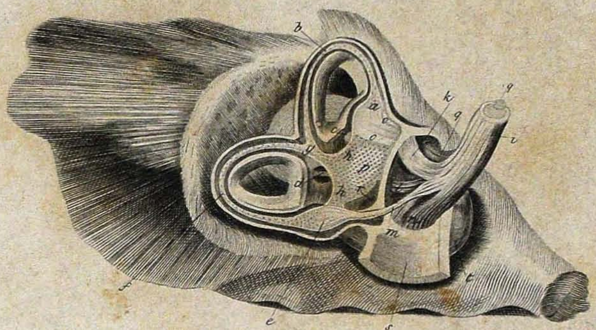
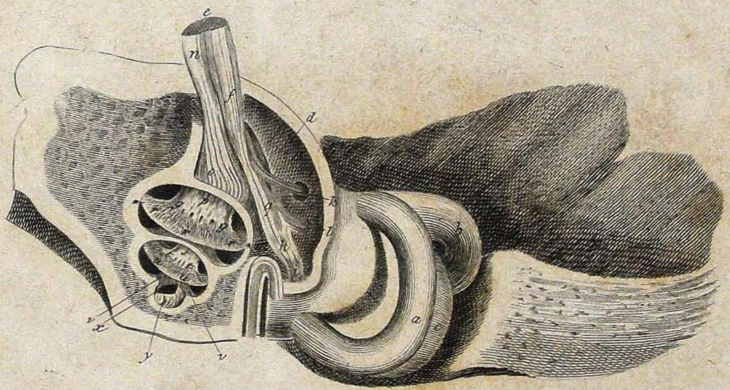


Fig. 2.



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D. Lizars Sculp.t

and brain. But the thalami nervorum, the optic nerve, and its expanſion into the retina, ſeem ſcarcely to have ever occurred to theſe ſpeculators, as worthy of notice in this inveſtigation.

The following appears to me the true account of this matter. It is demonſtrated, that the inner ſurface of the retina is a web of membrane conveying veſſels, and that the outer ſurface of the retina conſiſts of the pulpy-like nervous matter. This latter, then, is the organized ſurface adapted to receive the impreſſion of the rays of light. At the point where the optic nerve comes through the coats of the eye, there is no poſterior ſurface peculiarly adapted to receive the impreſſion of light; and, as well might we expect the optic nerve to be ſenſible to the impreſſion of light in any point of its extent from the brain to the eye, as at this; for here the inner ſurface of the retina only is formed; there is no poſterior ſurface upon which the rays can impinge. The doubts regarding the cauſe of this ſpot giving no ſenſation, have ariſen from the idea, that the internal ſurface of the retina, or its ſubſtance, felt the impreſſion of the rays of light.

At the ſame time, it is evident, that the choroid coat, and its ſecretion, is in a moſt remarkable manner ſubſervient to the retina, as the inſtrument of viſion: for, when the ſecretion is black, it abſorbs the rays; and animals which have ſuch a pigmentum nigrum, ſee beſt during the full day: again, when the ſurface is of a ſhining nature, it repels the rays, and this contributes to ſtrengthen the ſenſation; and ſuch animals are fitted for ſeeing in obſcure light: nay, further, if the ſurface of the choroid be coloured, the animal will

ſee

ſee objects of that colour the beſt, becauſe the colour of the choroid depends upon its reflecting more of the coloured ray, than of the others of which light is compoſed.

But as animals ſee which have no paint on the choroid, neither ſuch as will abſorb, nor ſuch as will ſtrongly reflect the rays, and which have merely the ſurface of the choroid with its coloured blood-veſſels in contact with the retina; ſo, it is evident, that it is not the deficiency of the choroid coat, nor the want of the black paint at the entrance of the optic nerve, which prevents the ſenſation, but really, that there is here no ſurface formed and organized to receive the impreſſion of the light; the outer ſurface not being the ſenſible ſurface of the retina.

FURTHER OBSERVATIONS ON THE RETINA.

It has already been obſerved, that viſion is the combined operation of the organ, nerve, and brain; conſequently, the deſtruction of the function may be produced by diſeaſe of the retina, of the optic nerve, or of the brain. Diſeaſe in the retina, nerve, or correſponding part of the brain, cauſing total blindneſs, while the cornea and humors of the eye remain pellucid, is called AMAUROSIS. It is, in general, to be conſidered as a paralytic affection. Amauroſis * has been

* AMAUROSIS; GUTTA SERENA; CATARACTA NIGRA; which laſt name is from the blackneſs of the pupil in conſequence of the tranſparency of the lens.

been found to follow ftrokes on the head; concuffion and compreffion of the brain; blood effufed within the fkull; or tumors preffing on the nerve or brain *. An amaurofis fpafmodica has been enumerated by authors. This kind of blindnefs has been fuppofed to arife in confequence of the ftricture of the optic nerve by the origins of the recti mufcles; as far as I have obferved, no action of thefe mufcles can affect the optic nerve before it perforates the coats of the eye. If it were to be attributed to the operation of thefe mufcles, I fhould rather fuppofe it to be occafioned by their fpafmodic action on the ball of the eye, by which the function of the retina might be difordered; but I think it is more probable that the fame irritation which is acting on the motatory nerves of the eye, does, in this inftance, affect alfo the optic nerve and retina. However, diftention of the coats of the eye, by encreafed fecretion of the humors, deftroys the fenfibility of the retina. In the hydrop-

* "Ipfe vidi bis in puerulis fcrophulofis amaurofin, etiam fubito ingruentem; fecto cadavere inveni glandulam ftrumofam nervis opticis incumbentem." *Sauvages Nofol.* From many obfervations, we find that tumors and extravafations, which muft comprefs gradually, do yet produce an inftantaneous effect.

In Bonetus *, we have many cafes of blindnefs from abcefs in the anterior part of the brain; from fluid on the furface, and in the ventricles; from fteatomatous tumors; from coagulum of blood, and from a hydatid preffing on the union of the optic nerves; and, laftly, from a calculus in the optic nerve. Blindnefs from preffure upon the eye and its difplacement, and confequent elongation of the optic nerve, by an encyfted tumor in the orbit, with gradual recovery after operations. See Med. Ob. and Inquir. vol. iv. p. 371.

* De Ocul. Affectibus, Ob. 2.

thalmia,

thalmia, there is in the beginning a ſhort-ſightedneſs, ſo that objects are ſeen only when near the eye. Thus far we might account for the defect of viſion by the alteration of the focus of the cornea and humors; but, by and bye, as the eye enlarges, as it becomes turgid, and the coats more diſtended, the pupil becomes ſtationary, and the viſion is loſt before the aqueous humor has become turbid *.

The connexion and ſympathy betwixt the retina and the viſcera of the abdomen is ſometimes very particular: I have ſeen frequently a proof of this in the diſorder of the ſtomach having an immediate effect on the ſenſibility of the retina. Allied to this, but greater in degree, is the amauroſis which attacks hyſterical women ſuddenly with head-ach and violent pain. From ſuch ſympathy of parts ariſe the amauroſis biloſa, verminoſa intermittens, arthritica, &c. Such attacks of blindneſs have been found to alternate with convulſions †.

The

* To complete ſuch a caſe, we may further obſerve, that there is now an acceſſion of pain, a tenſion over the forehead and pericrania, and there is ſometimes accompanying it a ſwelling and inſenſibility of the ſide of the face. So luxation or diſplacement of the eye, by tumors, cauſes blindneſs, by extending the optic nerve or compreſſing the eye-ball and conſequently the retina.

† The following is an ingenious account of the manner in which this may be produced, though to me it is not ſatisfactory:—" Non infrequens cæcitas poſt convulſiones graves et frequentes, ſed a nemine quod ſciam recte deſcripta cauſa; hanc non ab humoris affluxu deduco, ut voluerunt, ſed quia in magnis illis per paroxyſmas convulſionum partium omnium, et oculorum ſimul contorſionibus in quibus ſæpe quoque convulſi, admodumque exerti et inflexi apparent, attracto ſic nimium et tenſo nervo optico, illis adnato illoque ſimul

The amaurosis is a total blindneſs, while there is a tranſparency of the humors and coats of the eye. AMBLYOPIA is, on the contrary, only a partial privation of ſight, with a pellucid ſtate of the eye.

Commencing cataracts and opacities of the cornea, and of the humors in general, give occaſion to ſpots and obſcurities in the viſion *; but we have at preſent to conſider thoſe only which depend on the ſtate of the nerve †. Errors of viſion are not eaſily to be diſtinguiſhed from thoſe of the imagination proceeding from the brain. Error opticus, or Hallucinacio, from delirium:

ſimul contorto et læſo, ſpirituſque viſorii tranſitu impedito, oculos viſione privari contingit, atque inde provenire diligente examine & conſideratione invenimus." Platerus Prax. lib. i. c. 7.

* CALIGO is an obſcurity in the viſion, depending on obſtruction to the rays, from opacities before the pupil. "CATARACTA opacitas eſt ultra pupillam." AMBLYOPIA and AMAUROSIS are occaſioned by the diſeaſe of the nerve, or confuſion from the focal powers of the humors without opacity of any part. But Cullen extends the genus CALIGO to all obſcurities cauſed by opacity: he introduces the words "ob repagulum opacum, inter objecta & retinam," while Sauvage has the expreſſion "repagulum opacum citra pupillam."

† PSEUDOBLOPSIS is thus defined by Dr. Cullen: "Viſus depravatus ita ut quæ non exiſtant homo ſe videre imaginatur vel quæ exiſtunt aliter videt ac revera ſe habeant"—under this genus is SUFFUSIO, PHANTASMA. Under this definition all deceptions from refraction of the rays are naturally comprehended, as well as from the imagination ſimply: a definition comprehending defects of viſion which proceed from cauſes ſo very diſtinct, is an obſtruction to the knowledge of diſeaſes. Sauvage has it claſſed with the veſaniæ, viz. G. ſuffuſio, hallucinatio viſus circa objecta.

one

one diſtinction of the former is, that we can correct the deception by the aſſiſtance of the other ſenſes, while, in the latter, the mind is diſeaſed.

Old people are often troubled with the appearance of dark irregular ſpots flying before their eyes. In fever, alſo, it is very common to ſee the patient picking the bed-clothes, or catching at the empty air. This proceeds from an appearance of motes or flies paſſing before the eyes, and is occaſioned by an affection of the retina, producing in it a ſenſation ſimilar to that produced by the impreſſion of images; and what is deficient in the ſenſation, the imagination ſupplies; for, although the reſemblance betwixt thoſe diſeaſed affections of the retina and the idea conveyed to the brain may be very remote, yet, by that ſlight reſemblance, the idea, uſually aſſociated with the ſenſation, will be excited in the mind.

M. de la Hire attributed the fixed ſpots to drops of extravaſated blood on the retina, and the flying ones, to motes in the aqueous humors *; but we ſhall ſhow preſently, that this apparent motion of the motes before the eyes may be a deception. After turning round upon the heel for ſome time, objects apparently continue in motion. Dr. Porterfield ſuppoſed this to proceed from a miſtake with reſpect to the eye, which, though it be at reſt, we conceive to move the contrary way to that

* "Guttula cruoris retinæ inſidens et nigricans, omnem lucem intercipiet unde phantaſma obſcurum vel nigrum; verum ſi dilutus cruor radios rubros tranſmittat tunc maculam rubram videbit æger ut omnia trans vitrum inſpecta rubra ſunt." Sauvage, vol. iv. p. 287.

in

in which it moved before ; from which miſtake, with reſpect to the motion of the eye, the objects at reſt will appear to move the ſame way the objects are imagined to move, and, conſequently, will ſeem to continue their motion for ſome time after the eye is at reſt. How ſuperior is ſimple experiment to the moſt ingenious ſpeculation ! Dr. Porterfield is preſuming in all this, that the eye is at reſt when the body is ſtationary, after turning round rapidly on one foot. But the fact is, that the eyes continue in motion after the body is at reſt, but owing to a diſorder in the ſyſtem of ſenſation we are not ſenſible of it. Dr. Wells, in making an experiment, in which it was neceſſary to look upon a luminous body, was ſeized with giddineſs, and he found, that the ſpot on the retina, affected by the great excitement of the luminous body, did not remain ſtationary, but, when made apparent by looking upon the wall or any plane, was moved in a manner altogether different from what he conceived to be the direction of his eyes. In making the experiment after looking ſome time at a candle, and then turning himſelf round till he became giddy, he afterwards directed his eyes to the middle of a ſheet of paper, he ſaw the dark ſpot (cauſed by the former brilliancy of the candle on the retina) take a courſe over the paper, although he conceived that the poſition of his eyes remained ſtationary. He then directed a perſon to repeat this experiment, and then bade him look ſteadfaſtly to him, and keep his eyes fixed ; but inſtead of keeping ſtationary, his eyes were ſeen to move in their ſocket ; though, of this, the perſon himſelf was quite inſenſible.

 From

From theſe experiments, we may conclude, that ſpots which ſeem to move before the eyes are not, on that account, ſolely to be attributed to opacity of the humors or cornea, ſince the appearance of motion may be given to thoſe motes, though occaſioned by an affection of the nerve; eſpecially, if the unuſual ſenſation be attended with giddineſs. Giddineſs, however, is not neceſſary to ſuch ſenſation; when my eyes are fatigued, and, ſitting in my room, I look towards the window, I ſee before me ſmall lucid circles which ſeem to deſcend in quick ſucceſſion; upon attending more particularly to my eyes, I find them in perpetual motion; my eye is turned gradually downward, which gives to the ſpectrum the appearance of deſcending; but it regains its former elevation with a quick and imperceptible motion. During the ſlow inclination of the eye downward, the motes or little rings ſeem to deſcend; but in lifting the eye again, the motion is ſo quick, that they are not perceived *.

There

* The following quotation refers to this ſenſation:—"Aeger in magna luce conſtitutus, ut plurimum preſbyta, vel oculis nitidiſſimis gaudens, continuo præ oculis obſervari ſibi putat puncta lucida, quæ non huc et illuc volitant, nec a commoto capite agitantur, ut putat la Hire, et ejus in hoc exſcriptor Boerhaave; ſed conſtanter ſi oculus immobilis remaneat, deorſum lentiſſime delabi videntur; adeoque veluti pluvia aurea præ oculis eaque denſa cernitur; quæ verticaliter ſemper deſcendit in quacumque capitis poſitura, ſive erecta, ſive lateraliter inclinata; hoc in me ipſo expertus per annos, obſervavi in aliis, potiſſimum illis qui ſtudio nocturno indulſerant, et in aegrotante, qui de eo ſymptomate ad melancholiam fere per multos annos ſollicitus erat." Sauvages. This appearance has been attempted to be explained upon the ſuppoſition of a very ſenſible ſtate of the retina,

There is a kind of umbræ ſeen before the eyes which are occaſioned by the veſſels of the retina. Of this kind is the ſuffuſio reticularis of Sauvages, in which the perſon ſees umbrageous ramifications which ſtrike acroſs the ſphere of viſion, and are ſynchronous with the pulſe, ſhowing its dependance on the full and throbing pulſation of the head. There are alſo corruſcations ſeen before the eyes in conſequence of a blow upon the eye-ball, and accompanying violent head-ach, vertigo, phrenitis, epilepſy, &c. Whatever forces the blood with great violence to the head, as coughing, vomiting, ſneezing, will cauſe, for the inſtant, ſuch corruſcations, by means of the diſturbed circulation through the retina.

We are particularly called upon to attend to the connection betwixt the iris and the retina. In amauroſis, the ſenſibility of the retina being entirely loſt, the pupil is conſequently immoveable and dilated *. But we muſt recollect, that if one eye be ſound, the pupil of the diſeaſed eye follows, in ſome degree, the movement of the iris of the ſound eye. If one eye be

tina, which perceives the gutulæ exuding from the pores of the cornea, and which, falling over its ſurface, gives the appearance of their deſcending. But it is only felt when the retina is exhauſted or diſturbed by preſſure on the eye-ball. See Sauvages Suffuſio Scintillans & Suff. Danaës.

* There are, however, caſes of Amaurosis a myosi, in which there is a contracted and immoveable pupil, and children are born with an inſenſibility of the organ in which the pupil is not greatly dilated. I would be willing to attribute this peculiarity of the pupil and apparent amauroſis in newly-born children to the remains of the membrana pupillaris.

 ſhut,

ſhut, the pupil of the other eye will dilate; if the hand be put over the eye-lids of the ſhut eye, the pupil will ſtill further dilate *.

We find ſeveral inſtances of viſion indiſtinct during full day-light, and perfect in the crepuſculum. This we have explained by the dilatation of the pupil allowing the rays of light to paſs the partial opacity of the lens; it, of courſe, has no connection with the diſeaſe of the retina.

There are alſo inſtances of viſion being more than naturally obſcure in the twilight, which is owing to a degree of inſenſibility †. The night blindneſs, however, is not to be entirely attributed to a degree of continued inſenſibility in the nerve. The attacks are irregular, and allied to the intermitting amauroſis. It has been epidemic, and the following caſes ſeem to ally it with the paralytic affections.

* The ſympathy of the iris with the retina I do not conceive to be immediate, but through the intervention of the brain; and the degree of dilatation of the pupil, I ſhould hold to depend on the ſtrength of the common ſenſation of both eyes. By this only can we account for the ſenſibility of the retina of one eye affecting the iris of the other, or the diſturbance of the brain, in comatoſe diſeaſes, deſtroying the ſympathetic connexion betwixt the retina and pupil.

† Eſt immanis differentia inter ſplendorem et activitatem luminis candelæ et lunæ: luminis ſolaris vis eſt ad vim luminis candelæ 16 pedes diſtantis, obſervante D. Bonguer ut 11664 ad 1; et ad lumen lunæ in pleni lunio, ut 374000 ad 1 demonſtrante D. Euler Mem. de l'Acad. de Berlin, an 1750, pag. 299. non mirum itaque ſi vis toties major ſufficeret ad ſuccutiendam retinam quam tanto minor non afficiebat. *Sauvages Amblyopia Crepuſcularis.*

CASE

CASE I. OF NYCTALOPIA, OR NIGHT BLINDNESS, BY DR. HEBERDEN.

A man, about 30 years old, had, in the ſpring, a tertian fever, for which he took too ſmall a quantity of bark, ſo that the returns of it were weakened without being entirely removed; he therefore went into the cold bath, and after bathing twice, he felt no more of his fever. Three days after his laſt fit, being then employed on board of a ſhip, in the river, he obſerved, at ſun-ſetting, that all objects began to look blue, which blueneſs gradually thickened into a cloud, and not long after he became ſo blind as hardly to perceive the light of a candle. The next morning, about ſun-riſe, his ſight was reſtored as perfectly as ever. When the next night came on, he loſt his ſight again in the ſame manner; and this continued for 12 days and nights. He then came aſhore, where the diſorder of his eyes gradually abated, and in three days was entirely gone. A month after, he went on board of another ſhip, and after three days ſtay in it the night-blindneſs returned as before, and laſted all the time of his remaining in the ſhip, which was nine nights. He then left the ſhip, and his blindneſs did not return while he was upon land. Some little time afterwards, he went into another ſhip, in which he continued ten days, during which time the blindneſs returned only two nights, and never afterwards.

In the Auguſt following, he complained of loſs of appetite, weakneſs, ſhortneſs of breath, and a cough; he fell away very faſt, had frequent ſhiverings, pains

in his loins, dyſury, and vomitings; all which complaints encreaſed upon him till the middle of November, when he died. He had formerly been employed in lead-works, and had twice loſt the uſe of his hands, as is uſual among the workers in this metal. Medical Tranſactions, publiſhed by the College of Phyſicians in London, vol. i. p. 60.

CASE II. OF NYCTALOPIA, BY DR. SAMUEL PYE.

Pye, ſervant to a miller, at the 6th mill, on the Limehouſe wall, about 40 years of age, came to me October 2d, 1754, for advice and aſſiſtance. He told me, that about two months ago, while he was employed in mending ſome ſacks, near the ſetting of the ſun, he was ſuddenly deprived of *the uſe of his limbs* and of his ſight. At the time he was attacked with this extraordinary diſeaſe, he was not only free from any pain in his head or his limbs, but, on the contrary, had a ſenſation of eaſe and pleaſure; he was, as he expreſſed himſelf, as if in a pleaſing doſe; but perfectly ſenſible. He was immediately carried to bed, and watched till midnight; at which time he deſired thoſe who attended him, to leave him, becauſe he was neither ſick nor in pain. He continued the whole night totally blind and without a wink of ſleep.

When the day-light of the next morning appeared, his ſight returned to him gradually as the light of the ſun encreaſed, till it became as perfect as ever; when he roſe from bed, his limbs were reſtored to their uſual ſtrength and uſefulneſs, and himſelf in perfect health.

But

But on the evening of the fame day, about the fetting of the fun, he began to fee but obfcurely, and his fight gradually departed from him, and he became as blind as on the preceding night; though his limbs continued as well as in perfect health; nor had he, from the firft night, any complaint from that quarter.

The next day, with the rifing fun, his fight returned; and this has been the almoft conftant courfe of his difeafe for two months paft. From the fecond night, the fymptoms preceding the darknefs were a flight pain over the eyes, and a noife in his head, which he compared to a fquafhing of water in his ears.

After near two months continuance of the difeafe, on September the 29th, the patient was able to fee all night; on the 30th September, October 1 and 2, he was again blind all night; on the 3d, he was able to fee; on the 4th, he was blind till 12; on the 5th was blind. From this he had no return of his complaint till June 1755; from which time till the 3d of October, when I again faw him, he had three or four attacks; from the 3d till the 10th, he had an attack every evening.—He had at this time a purging. I ordered him an electuary of bark and nutmeg, which fucceeded in removing the blindnefs, but the diarrhæa continued wafting him. On the 20th, delirium came on; on the 21ft, he became deaf; he died on the 25th, after having fuffered from fever, pain in his bowels, and continued diarrhæa; but the defect in his eyes never returned after the 10th. This man had clear bright eyes: when his fight failed him the pupils were enlarged about one-third in diameter. Medical Facts and Enquiries, vol. i. p. 111.

Boerhaave gives us an example of imperfect viſion, from a diſcordance betwixt the contraction of the iris and the excitement of the retina; ſo that the pupil did not dilate in proportion to the decay of light *.

When inflammation extends within the eye, or when the retina is excited by ſympathy with the opthalmia of the outer membranes, it may happen that the patient is totally blind during the day, and yet ſees on the approach of evening; becauſe, from the ſenſibility of the retina, the pupil is abſolutely ſhut, but as the light is diminiſhed the pupil is gradually relaxed, and the obſcure light admitted, and this obſcure light, from the irritable ſtate of the retina, gives a vivid ſenſation incomprehenſible to the byſtanders. Our judgments of the ſtrength of ſenſations are comparative merely; when we have been accuſtomed to ſtrong impreſſions, leſſer ones are diſregarded. The greater light deſtroys the capacity of the retina for receiving ſlighter and more delicate impreſſions; while, on the other hand, the abſence of light reſerves to us the power of ſeeing objects the moſt faintly illuminated. We are every day becoming more acquainted with the inviſible properties of light; and we have frequent experience of darkneſs being relative, and that what we ſhould call total darkneſs is very often but a fainter light. One man will ſee diſtinctly, when another is quite deprived of the power of dicerning objects. A man in priſon ſeems to have the light gradually admitted to him; and

* In old people there is an obſcurity of viſion, from a diminiſhed ſenſibility of the retina; and the iris does not take a quick ſucceſſion of contraction and dilatation with the change of light.

many

many animals are in quick purſuit of their prey, while we are groping our way with the aſſiſtance of our other ſenſes.

Animals which ſeek their prey in a light which is darkneſs to us, have, moſt probably, a greater degree of ſenſibility of the retina. But they have alſo a more conſpicuous apparatus in the largeneſs of their eyes, and the dilatability of their pupil, while the ſenſibility which this proviſion gives, is often guarded from the light of day by the membrana nictitans, and by an iris capable of great contraction. Their iris poſſeſſes alſo a great power of contraction in narrowing the pupil during the day, as it is capable of dilating during the night, to the whole extent of the cornea. In the human eye, alſo, the ſtrict ſympathy between the iris and retina is a guard to the latter. But it has often happened that, in uſing optical inſtruments, the retina has been hurt by the intenſity of the light from the concentrated rays: a leſſer degree of this effect we have given us in the following inſtance *.

" Being occupied in making an exact meridian, in order to obſerve the tranſit of Venus, I raſhly directed to the ſun, by my right eye, the croſs hairs of a ſmall teleſcope. I had often done the like in my younger days with impunity; but I ſuffered by it at laſt, which I mention as a warning to others. I ſoon obſerved a remarkable dimneſs in that eye, and for many weeks, when I was in the dark, or ſhut my eyes, there appeared before the right eye a lucid ſpot, which trembled much like the image of the ſun ſeen by reflection from water.

* Viz. by Dr. Reid.

This

This appearance grew fainter, and lefs frequent by degrees, fo that now there are feldom any remains of it. But fome other very fenfible effects of this hurt ftill remain:—For, firft, the fight of the right eye continues to be more dim than that of the left; fecondly, the neareft limit of diftinct vifion is more remote in the right eye than in the other, although, before the time mentioned, they were equal in both thefe refpects, as I had found by many trials; but, thirdly, what I chiefly intend to mention is, that a ftraight line, in fome circumftances, appears to the right eye to have a curvature in it. Thus, when I look upon a mufick book, and, fhutting my left eye, direct the right to a point of the middle line of the five which compofe the ftaff of mufick, the middle line appear dim indeed at the point to which the eye is directed, but ftraight; at the fame time the two lines above it and the two below it appear to be bent outwards, and to be more diftinct from each other, and from the middle line than at other parts of the ftaff to which the eye is not directed. Fourthly, although I have repeated this experiment times innumerable within thefe 16 months, I do not find that cuftom and experience takes away this appearance of curvature in ftraight lines. Laftly, this appearance of curvature is perceptible when I look with the right eye only, but not when I look with both eyes; yet I fee better with both eyes together than even with the left eye alone."

Herfchel, in making his obfervations on the fun, found the irritation proceeding from the red rays (being thofe of the rays of light which have the property of producing heat in the greateft degree); he found, when

he ufed red glafs to intercept the too vivid impreffion of light on his eyes, that they ftopped the light, but produced an infufferable irritation from the degree of heat. But when he ufed green glafs, it tranfmitted more light, and remedied the former inconvenience of an irritation arifing from heat. He concluded, that in the darkening glaffes for telefcopes, the red light of the fun fhould be entirely intercepted. Boerhaave mentions an inftance of the retina being injured by the long ufe of the telefcope, and he himfelf was hurt by a fimilar caufe. Thefe injuries are owing to the intrufion of light highly concentrated, and over which the pupil has no command; it is a degree of intenfity which the organ is not prepared to counteract.

CHAP. VI.

OF THE MEMBRANA PUPILLARIS.

THE membrana pupillaris is an extremely vaſcular membrane, which is extended acroſs the pupil of the fœtus. It was diſcovered by Haller, Albinus, Wachendorf *, and Dr. William Hunter, at the ſame time or without correſpondence with each other. Haller †, after injecting, with oil of turpentine and cinnabar, a fœtus of the ſeventh month, ſaw through the cornea the veſſels of the iris injected, and ſome ramifications from them produced into the ſpace of the pupil. From conviction that no veſſels ramified without an involving membrane, he naturally concluded, that a membrane was drawn acroſs the pupil of the fœtus, though, in this inſtance, it was about to diſappear.

In ſeveral other fœtuſes of the ſeventh month he confirmed his firſt obſervation; and, cutting off the cornea, he obſerved the membrane impelled forward by the humors behind like a little veſicle.

Albinus, in his firſt book of Academical Annotations, thus deſcribes the way in which he detected this membrane. In the ſame child in whom he had filled the

* In Commercio Norico, A. 1740, hebd. 18. as quoted by Haller.

† De nova tunica pupillam fœtus claudente. Oper. minor.

veſſels

veſſels of the cryſtalline, he alſo firſt obſerved the membrane which cloſes the pupil, and in which the veſſels were injected that came from the margin of the pupil. Upon looking through the cornea, he could ſee no diſtinction of parts, but all ſeemed vaſcularity. He conceived, at firſt, that theſe were the veſſels of the uvea, and that it had quite contracted and had ſhut the pupil; then that they were the veſſels of the capſule of the cryſtalline lens; but having cut into the eye, he found it to be this membrane. Dr. Hunter, ſpeaking of this membrane, and of Albinus's claim to the diſcovery, ſays, "In juſtice to this great anatomiſt, I muſt declare that I believe this, both becauſe he aſſerts it and becauſe I know from the circumſtances it was hardly poſſible he could miſs taking notice of it in that child." "I have always obſerved (he continues), both in the human body and in the quadruped, that there is a great reſemblance to one another in the veſſels of the capſula criſtallini and of the membrana pupillæ. In an injected fœtus, I always find both nearly in the ſame ſtate: if one be filled only with the blood that is drove before the injection, ſo is the other; if one be filled partly with injection, and partly with blood, the other is in the ſame condition; if one, by good fortune, be finely and minutely filled by injection, the other is ſo too; if one be burſt by extravaſations, the other is commonly in the ſame ſtate; and when the fœtus is ſo near its full time that the one cannot be injected, neither can the other *."

* See Medical Commentaries, p. 63. foot note.

Dr. Hunter,

Dr. Hunter, ſpeaking further of the artery of the criſtalline capſule, ſays, "that it does not terminate at the great circle of that humor. Its ſmall branches paſs that circle, and run a very little way on the anterior ſurface of the criſtalline humor before the points of the ciliary proceſſes; then they leave the humor and run forwards, ſupported on a very delicate membrane, to loſe themſelves in the membrana pupillæ." He continues: "The membrana pupillæ receives two different ſets of arteries, one larger, from the iris, and the other much ſmaller, but very numerous from the criſtalline capſula."

Now I think that every expreſſion in theſe excerpts confirms the opinion I entertain, that theſe veſſels which are ſeen filled with red blood, and which take their courſe through the humors, are ſubſervient merely to the membrana pupillaris.

The firſt time I obſerved the membrana pupillaris was in the eye of a child born at the full time. I had injected the child very minutely with ſize and vermilion, and the iris was beautifully red and the pupil quite tranſparent and black, and not obſcured by any extravaſation of the injection into the aqueous humor: upon very narrowly obſerving the circle of the iris, I ſaw diſtinctly a ſmall injected veſſel paſs out from the edge of the iris, and croſſing the pupil, divide into two branches which ran into the oppoſite margin of the iris. This was the remains of the membrane, but ſo delicate and ſo perfectly tranſparent, that the preſence of it was only to be argued from the veſſel which was ſeen to croſs the pupil.

Since

Since that time I have often feen it in the early months, and particularly ftrong about the feventh month of the fœtus. It is then an opaque, and very vafcular membrane, and generally it has fpots and ftreaks of extravafation in it. The vafcular ftructure of this membrane is very particular, and I can affign no other reafon for this than that it may be a provifion for its rapid abforption. It has evidently two fources of veffels, viz. the veffels of the capfules and thofe of the iris; but whether the arteries come by the one fource, and the veins depart by the other, I cannot as yet determine. In one preparation I fee the veffels with their trunk in the membrana pupillaris, and the branches fent over the furface of the iris.

The larger and flat venous-like veffels of the membrane are diftributed in a beautiful net-work, in the form of the lozinge of a Gothic window. They have a free communication with each other. In their whole courfe the veffels feem nearly of the fame fize, (which alfo is like the character of a venous net-work), and they terminate apparently in the margin of the iris.

The ufe of the membrana pupillaris I think fufficiently apparent, though I do not find that it has hitherto been underftood. Haller makes a comparifon betwixt this membrane, which clofes up the pupil, and that matter which is accumulated in the paffage of the ear in the fœtus. But there is no analogy.—As the waters of the amnios might otherwife be in contact with the membrane of the drum of the ear, and injure what neceffarily is of a dry and arid nature, to adapt it for receiving the vibrations of the air, this matter accumulated in the ear of the fœtus defends it. But at the time,

time, when the membrana pupillaris exiſts in its full ſtrength and vaſcularity, no light is admitted into the eye—the fœtus is lying in its mother's womb. Towards the ninth month, the membrane has become tranſparent, and if not totally abſorbed, it is torn by the firſt motion of the pupil and altogether diſappears. It can therefore have no effect in obſcuring the light, and preventing it from exciting in too great a degree the eye of the newly-born child. To explain the effect of this membrane, then, we have only to conſider that it is of the nature of the iris to contract its circular fibres during the operation of light, ſo as to cloſe or nearly cloſe the pupil; that, on the other hand, the pupil is completely dilated through the operation of the radicated fibres of the iris in darkneſs:—To the queſtion, then, why it is not dilated during the fœtal ſtate? The anſwer, I think, is decidedly this:—The iris is not looſe in the fœtal ſtate, it is connected and ſtretched to the middle degree of contraction and dilatation by the membrana pupillaris. Were the iris in a full ſtate of contraction, during the life of the fœtus, it could not receive its full nouriſhment, proper degree of extenſion, and due powers; but being preſerved ſtationary and extended, the diſpoſition to contraction, which it muſt have when the retina is without excitement, is counteracted, until it is about to receive, by the birth of the child, that degree of excitement which is to keep up the preponderance towards the contracted ſtate of the pupil.

CHAP. VII.

OF THE HUMORS OF THE EYE.

OF THE AQUEOUS HUMOR.

THE aqueous humor is perfectly limpid. It has no capſule or ſurrounding membrane, as it is not in conſiſtence allied to the other humors, but is fluid *. The uſe which I have aſſigned to the aqueous humor explains its nature and the extent of the chamber which contains it, viz. that it diſtends the cornea and allows the free motion of the iris; it conſequently fills the ſpace between the lens and cornea. The uſual deſcription is, that it is lodged in two chambers; the one before the iris, called the anterior chamber of the aqueous humor, and the other behind the iris, called the poſterior chamber of the aqueous humor.

This poſterior chamber was, at one time, conceived to be of great extent †, and authors ſpoke of depreſſing the lens into the poſterior chamber of the aqueous humor ‡.

* It poſſeſſes, however, a degree of viſcidity. Winſlow.

† Viz. by Heiſter. They were called the firſt and ſecond chambers by M. Briſſeau.

‡ There certainly appears ſufficient room for this in Veſalius and Briggs plates: theſe plates have miſled many.

It is found, now, that betwixt the lens and iris there is no ſpace to which we ought to give this name of chamber.

Heiſter, Morgagni, and M. Petit (medecin) firſt demonſtrated the extreme ſmallneſs of the poſterior chamber, and after them Winſlow confirmed the fact, that the iris moved almoſt in contact with the anterior ſurface of the lens.

M. Petit gave the cleareſt proof of the ſmallneſs of the poſterior chamber, by freezing all the humors of the eye, and diſſecting them in their ſolid ſtate. Without this expedient it was impoſſible to prove the relative ſize of the two chambers; for, whenever the cornea was cut, the aqueous fluid eſcaped, and the lens puſhed forward. When the eye was frozen, and then diſſected, it was found that the ice, which took the ſhape and dimenſions of the anterior chamber, was much larger than that found in the poſterior chamber*; indeed the latter was formed of a very thin flake of ice. The thin piece of ice in the poſterior chamber indicated as much fluid only betwixt the iris and lens as might allow a free motion to the iris. Theſe experiments were inſtituted in the courſe of inveſtigating the queſtion of the nature of the cataract.

The concluſion, that the poſterior chamber of the aqueous humor contained but one-fourth of the whole aqueous humor, was admitted with great difficulty and after much conteſt. It determined the queſtion, whether the cataract was a membrane or the opaque lens; for, as thoſe who maintained that it was a membrane, ſaid it could not be the lens, becauſe the lens was far

* See Acad. Roy. des Sciences, 1723. Mem. p. 38.

diſtant from the iris, it was neceſſary for their opponents to prove that the lens was cloſe upon the pupil, and that the poſterior chamber of the aqueous humor was very ſmall.

It is agreed that, in the adult, the quantity of the aqueous humor amounts to five grains; in the fœtus it is red, turbid, and weighs about a grain and a half, owing, in part, to the comparatively greater thickneſs of the cornea.

As it is natural to conceive that the aqueous humor flows from a vaſcular ſurface, it is the moſt generally received opinion, that it is derived from the points of the ciliary proceſſes and ſurface of the iris. Haller, particularly, and after him Zinn, have thought that the ciliary proceſſes were the ſecreting bodies; but there is one argument which, in my mind, determines that theſe are not the ſole ſecreting parts, viz. that while the membrana pupillaris cloſes up the communication betwixt the two chambers, I have obſerved the anterior one to be full of the fluid, which of courſe muſt have been ſupplied from another ſource than the ciliary proceſſes. I ſuppoſe, therefore, that the vilous ſurface of the iris is the proper ſecreting ſurface of the aqueous humor *. Zinn obſerves, that Haller ſaw the mem-

* The opinion of Nuck is now out of the queſtion. He thought that he had diſcovered particular aqueducts, which conveyed the aqueous humor into the anterior part of the eye; but theſe are found to be nothing more than the ſhort ciliary arteries which pierce the fore part of the ſclerotica. M. Merry and Bonhomme, (ſee Zinn, p. 143.) obſerved, in an adult, the pupil cloſed with a membrane, and, in this inſtance, there was ſcarcely any fluid in the anterior chamber, whilſt the poſterior was turgid with fluid.

brana pupillaris diſtended and bulged forwards by the aqueous humor in the poſterior chamber. It is ſcarcely neceſſary to ſay, that this muſt always take place when the cornea is firſt opened in demonſtrating that membrane, whether there be a watery fluid behind it or not. But I believe I ſhall be able to prove, that the ſecretion of the ciliary proceſſes can have little power of filling the poſterior chamber, even from the connexion of membranes behind the membrana pupillaris in the fœtus. The aqueous fluid is perpetually undergoing the change of ſecretion and abſorption, and this is the reaſon of its quick renewal when it has been allowed to eſcape by puncture of the cornea. The ancients were not ignorant of the quick regeneration of this fluid. It was proved to the moderns by a charlatan, Joſephus Burrhus (ventoſus homo, qui in carcere Romano perut). Before the phyſicians of Amſterdam he punctured the cornea of a dog; then inſtilling his liquor under the cornea, he bound up the eye; in a few days he took off the bandage, and ſhowed them the cornea again diſtended with the aqueous humor. It was ſoon found that the inſtilled fluid was of no kind of conſequence. Redi and Nuck made many experiments, and it was found that the aqueous humor was regenerated in the courſe of 24 hours.

When the diſputes regarding the cataract ran high, and when, to make new diſtinctions in the diſeaſe was taken as a mark of practical knowledge and of acuteneſs, there was a kind of cataract attributed to the aqueous humor. When the aqueous humor became turbid, white, and opaque, and obſcured the pupil, they were abſurd enough to call this a cataract. The turbid ſtate

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of the aqueous humor is at once diſtinguiſhable, from the opaque lens, becauſe it obſcures the iris as well as the pupil.

Pus is formed in the chambers of the aqueous humor, in conſequence of deep inflammation, contuſions, &c. and from the ſame cauſe, ſometimes, proceeds a bloody effuſion. When the pus has lodged in the anterior chamber of the aqueous humor, it would appear, upon the authority of Galen, that an oculiſt of his day performed a cure by ſhaking the patient's head *! It is an operation of oculiſts to puncture and allow the pus to flow out, and ſome have even ſyringed out the pus with water †; but this muſt have been on the principles of Joſ. Burrhus's exhibition; for the natural ſecretion is here the beſt deluent. When we recollect the nature of the parts with which the pus lies in contact, we cannot be ſanguine in the hope of ſuch an operation ſaving the eye. Sometimes there remains, after operation on the cornea, or in conſequence of ulceration, a continued flow of the aqueous humor; the conſequence is a ſubſiding of the cornea ‡: it becomes corrugated, opaque,

* Mouchart ſays, he has often ſeen the oculiſt Woolhouſe repeat this cure by ſhaking his patient's head over the ſide of the bed. He attributed the cure to the falling of the pus into the poſterior chamber, which, he ſuppoſes, has parts more capable of abſorbing it.

† They were at variance regarding the place at which to puncture for this diſcharge:—Some did it behind the iris; there we know there is a crowd of veſſels; the beſt place is the lower edge of the cornea before the iris. It ſeems to have been no uncommon accident, in this operation, to find the lens protruded through the pupil. The reaſon of this has been already explained.

‡ Rhytidoſis, ſeu ſubſidentia & corrugatio corneæ.

and, from the contact of the iris, apt to adhere to the iris. In consequence of this suppuration, there sometimes follows an absolute obstruction of the pupil, from the coalescing and adhesion of the edges of the iris *.

THE VITREOUS HUMOR.

The vitreous humor, as already explained, occupies almost entirely the great ball of the eye. It is consequently beyond the lens, and keeps it at the requisite distance, to cause the rays from objects to concentrate and impinge upon the retina. The vitreous humor is considerably denser than the aqueous humor †; but its peculiar appearance, its glairy-like consistence, is not owing to its density, but to the manner in which it is contained in its membranes. From being contained in a cellular structure of perfectly pellucid membranes, it has the adhesion and consistence of the white of an egg. This membranous structure of the vitreous humor has been demonstrated by acids and by freezing. When frozen, it was found to consist of pieces of ice connected by strong membranes, which separated with difficulty, and showed their torn fragments; and M. Demours lifted the transparent membranes with the point of a needle. Although the vitreous humor appears to be gelatinous, it is not so in reality, and when it is taken from the coats of the eye, it retains the shape for a time, but gradually subsides by the fluid exuding

* Viz. Synifesis. There has occurred congenital imperforation of the pupil.

† It is, according to Dr. Monro, in the proportion of as 1016 to 1000.

from

from the membranes, and this is accelerated by puncturing it.

OF THE CRISTALLINE LENS.

The criſtalline humor is a ſmall body, of the ſhape of an optician's lens, of great power. It is of perfect tranſparency, and of denſity much greater than the vitreous humour. Its denſity to that of the vitreous humor is calculated to be as 1114 to 1016. But the criſtalline is not of uniform denſity, for the centre forms a denſer nucleus.

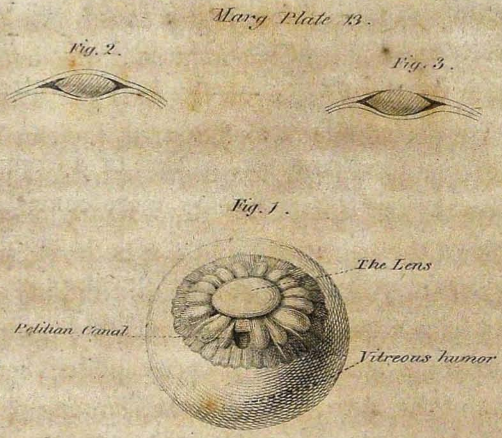
The form of the cryſtalline is that of a compreſſed ſphere, the anterior ſurface being more compreſſed or flatter, though, in a degree, convex. According to Petit, the anterior ſurface is the ſegment of a ſphere whoſe diameter is 7, 8, or even nine lines. The poſterior ſurface is a ſphere of $4\frac{3}{4}$ or 5, or $5\frac{1}{2}$ lines in diameter. The internal ſtructure of the lens is quite peculiar, and reſembles neither the vitreous nor the aqueous humor. By maceration, it ſplits into lamellæ, and at the ſame time burſts up into equal parts, ſo that there is firſt a ſtellated-like fiſſure, and then it ſeparates into pretty regular diviſions; and after maceration in acids, the lens can be teaſed out into minute ſhreds and fibres *.

From its form, denſity, and central nucleus, it has great power of converging the rays of light; and in an eye properly conſtituted, it concentrates them accurately to the ſurface of the retina. For this reaſon, it is placed before the vitreous humor, and ſocketed in its anterior

* See further of the muſcularity of the lens.

part. It is contained in a capſular membrane, which membrane is continued from, or connected with, the membranes of the vitreous humor; but this is a ſubject which requires a more particular inveſtigation.

OF THE CAPSULE OF THE LENS AND VITREOUS HUMOR.



In fig. 1, we have the appearance of the Petitian canal blown up. It is not found full of any fluid, it is only the laminæ of membrane inflated, and it is beſt demonſtrated by cutting off the cornea, and with it a ſmall circular portion of the ſclerotica, and taking with theſe the iris alſo, when the lens preſents itſelf ſeated firmly in its capſule on the vitreous humor. Now laying back the ciliary proceſſes, we make a fine puncture with a lancet by the ſide of the lens, and then blow gently into it with the blow-pipe.

Every

Every anatomiſt acknowledges the exiſtence of the Petitian canal, and a diſtinct capſule to the lens is alſo pretty generally allowed. But many deny that the vitreous membrane has two plates, without obſerving that the exiſtence of the Petitian canal is a proof of the ſplitting of the membrana vitrea, on the fore part at leaſt. Some believe that the vitreous membrane ſplits and involves the lens, and forms its capſule; but the difficulty, on this ſuppoſition, is ſtill to account for the formation of the canal which ſurrounds the lens; for as the fluids on the ſurface of the lens and within its capſule have not admiſſion to the canal, the canal muſt be diſtinct; and, indeed, ſometimes we blow up the circular canal, and ſometimes, by a wrong puncture, the capſule of the lens itſelf; but not both at once.

Seeing, then, that theſe cavities are diſtinct, ſome anatomiſts have admitted that the membrana vitrea is double; that the lens has its proper capſule; and that the lamina of the vitreous membrane, coming near the margin of the lens, ſplits and involves it in a ſecond coat, (as in fig. 2.) Others have ſuppoſed that the anterior layer of the vitreous humor does not paſs over the anterior ſurface of the proper capſule of the lens, but only adheres to the edge of the capſule of the lens, and forms the Petitian canal. There are yet others who have deſcribed the membrana vaſculoſa of the retina as forming the capſule of the lens. This is one of thoſe pieces of anatomy which provokes us to continued reſearch, and mortifies us with continual diſappointment. If this piece of anatomy, when inveſtigated in the eye of an adult, is difficult to be underſtood, it is infinitely more complicated in the eye of the fœtus;

fœtus; and, for my own part, I cannot reconcile my experience with any former opinion.

I conceive that it is the membrana vaſculoſa tunicæ retinæ, or membrana vaſculoſa Ruyſchii, which forms the vaſcular capſule of the lens in the fœtus, and alſo the canal of Petit in the adult. The criſtalline lens has, in the firſt place, its proper capſule, which ſurrounds it on all ſides: again, the tranſparent web of membrane that is continued onward from that part of the retina which has upon it the pulpy and nervous expanſion, ſplits when it approaches the margin of the lens. One lamina goes round behind the lens, and the other paſſes a little before it, forms an adheſion to the capſule of the lens, and is then reflected off to the points of the ciliary proceſſes and to the membrana pupillaris of the fœtus *. Betwixt theſe ſplit laminæ of the continued membrane of the retina the canal, which ſurrounds the lens, is formed. The membrana vitrea is ſimply reflected over the back of the lens, and has no part in forming the Petitian canal. Where the retina advances forward upon the ciliary proceſſes, it forms an adheſion, beyond which the medullary part is not continued; but the membrana vaſculoſa paſſing onward, as I have deſcribed, embraces the lens, and the

* In the fœtus, as far as I have obſerved, the proper capſule of the lens and the membrana pupillaris lie in contact, but they do not adhere; and while the membrana pupillaris is perfectly red with injection, there is none to be ſeen on the fore part of the capſule. There is, indeed, no part of that ſurface which is afterwards to ſecrete the aqueous humor, which could ſecrete that fluid, betwixt the ſurface of the lens and membrana pupillaris: ſo complete is the adheſion of the adventitious and vaſcular tunic of the lens to the membrana pupillaris.

lamina,

lamina, which paſſes behind the lens and before the vitreous humor, receives and conveys the artery of the capſule; on the fore part of the lens the anterior lamina only touches the capſule of the lens, adheres, and is then reflected off to form the membrana pupillaris.

In this account I am ſupported by the moſt careful inveſtigation, and by the ſimplicity of this ſyſtem of veſſels: for it will be obſerved, that it is on the membrana vaſculoſa alone that the veſſels, carrying red blood in the fœtus, are ſupported, and that it ſhows throughout the ſame character for vaſcularity. Again, I think it probable that this membrane which paſſes before the lens, viz. the membrana pupillaris, and that which paſſes behind the lens, forming the vaſcular capſule of the lens, diſappears at the ſame time; or if this poſterior and vaſcular membrane which paſſes behind the lens is not totally abſorbed, it becomes thin and more intimately united to the membrana vitrea.

CHAP. VIII.

OF THE DISTRIBUTION OF THE CENTRAL ARTERY AND VEIN OF THE RETINA.

I AM the more anxious to give the accurate diſtribution of theſe veſſels, that Walter's account of them has tended much to derange that ſimple and natural view of this ſyſtem which obſervation authorizes us to take.

The arteria centralis retinæ ariſes from the opthalmic artery *. Sometimes it is derived from the ciliary arteries before they enter the coats of the eye, and often there is more than one branch entering the optic nerve †. Ariſing from this ſource, there are many branches which are diſtributed to the retina, while a branch paſſes onward from the lamina cribroſa through the vitreous humor to the capſule of the lens. This veſſel does not paſs exactly in the centre of the vitreous humor, but to one ſide of the axis of the eye. When it arrives near the capſule of the lens, it divides into three or four branches, which, reaching the capſule, ſpread beautifully on the back part of it ‡.

The

* See Haller, Faſcic. vii. tab. vi. fig. 2. 4. 7.

† Haller, F. vii. p. 42.

‡ Walter (de venis oculi) ſays, the arteria centralis retinæ, having perforated the membrana hyoloidea, paſſes through the middle of the vitreous humor, and ſcatters ſome twigs on the ſmall cells of the vitreous

The BRANCHES of the arteria centralis retinæ, which are diſtributed in the retina, are ſubſervient to its ſupport, and are conſequently as viſible in the adult as in the fœtus; and, where the membrane of the retina has been deſcribed as adhering to the point of the ciliary body, theſe veſſels of the retina unite to, or inoſculate with the veſſels of the ciliary proceſſes.

Walter objects to the deſcription of the arteria centralis retinæ given by Haller and others; he ſays, decidedly, that there are no arteries diſtributed to the retina, and that anatomiſts have deceived themſelves in ſuppoſing thoſe veſſels which ramify on the retina, to be arteries, when, in reality, they are veins; he conceives, that the free return of the injection from the extremities of the arteries into the veins has miſled them.

I am at a loſs to conceive what notions profeſſor Walter can have entertained regarding this vein diſtributed in the retina, without an accompanying artery. It is a ſuppoſition contrary to the general frame of the œconomy, and I would oppoſe to it, with confidence, my own experience, ſince, in the ox and other animals, I have ſeen the veins of the retina turged with blood and exceedingly diſtinct; yet when I injected the trunk of

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vitreous humor. It does not, he ſays, run through the vitreous humor in a ſtraight line from behind, forward, nor does it divide into a great number of branches in the poſterior part of the capſule of the lens, like radii from a centre, as Zinn has deſcribed. He aſſerts that the lens receives its veſſels from the inveſture of the membrana hyoloidea, and that they run back from the edge of the lens towards the poſterior convexity.

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the artery at the root of the optic nerve, I found a ſet of veſſels injected on the ſurface of the retina quite diſtinct from the turgid veins, and which could be no other than the arteries diſtributed to the retina. I muſt conclude that there is no peculiarity in the diſtribution of veſſels in the tunica vaſculoſa retinæ.

We frequently obſerve, that the trunks of veins and arteries, deſtined to the ſame final diſtribution, take a different courſe; but in their final diſtribution, I know no inſtance in which they do not ramify with parallel branches interwoven with each other.

The VENA CENTRALIS RETINÆ, as it is deſcribed by Haller, is ſometimes a branch of the opthalmica cerebralis, but often it riſes from the cavernous ſinus, amongſt the origins of the external and inferior recti muſcles of the eye; after giving off many ſmall twigs to the perioſteum and fat of the orbit, it paſſes obliquely from behind, forward, and inward, perforates the ſheath of the optic nerve, and, after ſupplying the ſheath, dips into the ſurface of the nerve.—It is now the comes arteriæ centralis retinæ. It enters through the cribriform plate of the optic nerve, and ſpreading generally in large and remarkable branches on the retina, theſe make free inoſculations with each other, and finally inoſculate with the veins of the ciliary proceſſes.

Whether a branch of the vena centralis retinæ is ſent off to accompany the branch of the artery which takes its courſe through the vitreous humor, I have not been able to determine.

CHAP. IX.

OF THE VASCULARITY OF THE PELLUCID MEMBRANES.

If we cut through the ſclerotic and choroid coat, round the optic nerve as it enters the eye, and afterwards cut up the outer coats towards the cornea, the humors fall out from theſe coats, and will remain ſuſpended in a fluid, hanging by the optic nerve and cloſely embraced by the retina: we have now to review theſe parts taken collectively, independant of the outward and proper coats, and, as I have claſſed them, as conſtituting the internal globe of the eye.

The firſt peculiarity which ſtrikes us here is the perfect tranſparency of all the parts within the embrace of the retina. As there are, in the adult and healthy eye, no veſſels to be ſeen in the tranſparent membrane and humors, it becomes a queſtion, whether nature has provided for the ſupport and nouriſhment of thoſe parts by other means than the common circulation of red blood through veſſels? Now, I am inclined to think, that there is no ſuch circulation through them; and I believe, that this would be much more generally allowed, were there not ſomething like a proof remaining in men's minds that theſe humors and tunics were ſupplied with red blood in the fœtus; whence they deduce the natural conſequence that, in the adult ſtate,

 theſe

these veſſels are only ſhrunk ſo as to convey only colourleſs fluids. I have, therefore, in the firſt place, to give my reaſons why I think that theſe veſſels of the fœtus are not ſubſervient to the humors; and, I think, I ſhall prove that, when they have once diſappeared, they are no longer pervious veſſels; that, though thoſe parts which they are ſuppoſed to ſupply, ſhould become inflamed and vaſcular in the adult, theſe veſſels which were apparent in the fœtus do not become enlarged; that they do not adminiſter in any way to inflammation and diſeaſe, but that a new ſource is given, and that veſſels are formed which were at no former period diſcernable.

Why ſhould there be red blood tranſmitted to the pellucid membranes and humors of the fœtus? Why is not that ſtate of circulation, which nouriſhes and ſupports the parts in the adult ſtate, ſufficient for their growth and the progreſs to perfection which they undergo in the fœtus? Why is the capſule of the lens only crowded with veſſels carrying red blood, while the proof of veſſels paſſing to the cells of the vitreous coat ſtands upon ſome very rare and vague aſſertions, and ſuch as can be naturally explained by the appearance of thoſe veſſels which merely paſs through the vitreous humor for a different deſtination?

I believe this is a view which has been little attended to; but, upon the moſt minute enquiry, and upon examining the preparations of the vaſcularity of the eye of the fœtus, I can ſee no veſſels, paſſing into the humors and carrying red blood, which are not finally diſtributed to the membrana pupillaris. When we lay open the eye of a fœtus, after a very minute and ſucceſsful

cefsful injection, we fee veffels, which all proceed from the centre of the optic nerve, paffing through the vitreous humor to the back of the capfule of the lens, viz. the branches of the arteria centralis retinæ. This artery divides very often into many branches before it arrives at the capfule of the lens: now, if thefe be filled with blood, or but partially injected, they have the appearance of being branches diftributed to the vitreous humor, and not to the lens. This appearance is ftill more apt to deceive us when the lens is feparated from the vitreous humor, and when the vitreous humor is otherwife difturbed, for then the veffels fhrink and feem to terminate in the midft of the vitreous humor. When the injection is perfect there is no fuch appearance.

On the back of the lens we fee a profufion of veffels; but I think I may pofitively fay that thefe veffels do not penetrate to the lens itfelf, but are merely on the capfule, and that having made the circuit of the lens, they terminate in the membrana pupillaris and ciliary body. I can obferve no villi on the inner furface of the capfule of the lens, nor any appearance of its being a fecreting furface, to lead me to fuppofe that thefe veffels fecrete the lens, as Walter fuppofes they do; nor, after the moft fuccefsful injection of the capfule of the lens and of the coats of the eye in general, can I obferve the flighteft ftain of colour in the pellucid ftate of the lens, nor betwixt its white fibres when it becomes opaque. Nor have I obferved, at any time, a fingle branch of thefe veffels, which are fo profufe on the back of the lens, diftributed to the anterior part of the capfule; on the contrary, they all terminate abruptly at that line, a

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little forward from the utmoſt verge of the lens, where they are united to the veſſels of the membrana pupillaris and ciliary proceſſes. Were theſe veſſels of the capſule provided for the ſecretion of the lens, or were thoſe veſſels the trunks of leſſer branches which pierce into the ſubſtance of the lens, they would appear alſo on the fore part of the capſule.

If I am accurate in theſe obſervations, we are authorized to deduce this important concluſion:—that theſe veſſels which we ſee running through the vitreous humor and capſule of the lens, and which are ſometimes ſeen filled with red blood or injected with ſize and vermillion, are not the veſſels of the humors, but veſſels in their paſſage to the membrana pupillaris, and that they diſappear totally when that membrane is abſorbed. They are injected when the membrana pupillaris is injected; they are more difficult to fill when that membrane is becoming pellucid and tender towards the latter period of geſtation; and with the annihilation of the membrane follows the diſappearance of the veſſels carrying red blood through the tranſparent humors of the eye.

In confirmation of the total annihilation of theſe central veſſels of the vitreous humor, I have found that, when diſeaſe comes upon the lens of the adult, the veſſels, which are apparent in conſequence of inflammation, do not proceed through the old tract from the centre of the optic nerve and through the vitreous humor to the lens, but that they come from the extremity of the retina and laterally, and thence ſpread over the back of the lens.

An eye, which I had lately an opportunity of examining, confirmed me in this opinion. I aſſiſted my brother in an operation on the eye, in which, the anterior part being diſeaſed, it was cut away. I had ſoon an opportunity of retiring and examining the parts with Dr. Monro. I obſerved, then, an opaque ſpot on the poſterior ſurface of the lens, which was, indeed, in the capſule, and to this ſpot there came veſſels over the margin of the lens from the extremities of the veſſels of the retina; but, in the vitreous humor, there were no veſſels to be ſeen, nor any branches paſſing into the lens obliquely from behind, as they do in the fœtus.

CHAP. X.

SOME SURGICAL OBSERVATIONS CONNECTED WITH THE ANATOMY OF THE HUMORS.

I HAVE already mentioned, as the principle of the operation of extracting the lens, that the ſimple action of the muſcles, ſurrounding the eye-ball, is ſufficient to protrude the lens, if the inciſion of the cornea be of proper dimenſions relative to the ſize of the lens. No doubt, if there have been thickening inflammation and perhaps preternatural adheſions of the membranes ſurrounding the lens, the operation will neceſſarily become more complicated; the lens will not glide at once over the cheek when the inciſion of the cornea is completed. But ſtill, I think, we are not to allow ourſelves to conſider it as a ſtep of the operation, in any circumſtances, that the ball of the eye is to be preſſed; becauſe, in that caſe, the membranes of the lens give way ſuddenly, and part of the vitreous humor unavoidably is protruded with it, or the edge of the lens is turned obliquely to the pupil, and the vitreous humor eſcapes by the ſide of it. It is better to deſtroy the adheſions with the inſtrument, and to ſcratch the capſule of the lens ſo that it may burſt. Whence it is evident that it is neceſſary, in order to inſure the correct performance of the operation of extraction, that the lens ſhould preſs equally forward on the pupil, and that the pupil ſhould be allowed

lowed to dilate. From this it appears, how loofe the ideas of thofe are who can fpeak of trying firft to couch, and if that is not found to fucceed, then to perform the operation of extraction. I conceive the attempt with the needle to preclude the operation of extracting, for thefe reafons :—An unfuccefsful attempt to deprefs will, in general, be a laboured and reiterated motion of the point of the needle, which muft occafion inflammation and an adhefion firmer than is natural. Again, in couching, the lens is removed from the axis of the eye fo far only that, in the cafe of the extracting being attempted, it no longer equally oppofes itfelf to the pupil, the confequence of which muft be, the efcape of the vitreous humor and the detenfion of the lens.

In regard to the place at which the couching needle is to be introduced, we may obferve, that we are directed, by the older furgeons, to pierce the fclerotic coat very near to the edge of the cornea, becaufe they were afraid of hurting the lens with the needle! The idea then entertained was, that the cataract was a membrane hung behind the pupil and before the lens. The older furgeons had the idea that the needle entered before the lens, and paffed at once into the aqueous humor. We are to difregard thefe injunctions of furgeons who directed the needle to be introduced with the idea of avoiding the lens; for, while their notions regarding the difeafe were erroneous, their rules of operating could not be correct: accordingly, we find them differing in their directions as to the place of piercing the cornea; fome directing us to pierce it at the diftance of one line from the edge of the cornea, others at the diftance of four lines and a half.

Now that we know the place of the cataract, and know alſo that it is the opaque lens, we can be at no loſs to introduce the needle correctly. If, ſays M. Petit, we pierce the ſclerotic coat one line from the edge of the cornea, we pierce the tunica conjunctiva, ſclerotica, choroid, vitreous humor, and ciliary proceſſes before the needle enters the cataract. In this puncture, we wound the moſt vaſcular part, and, indeed, every delicate part of the eye; for even in this moſt anterior courſe, the retina is equally lacerated with the others *. But if we pierce the ſclerotic coat, three lines from the edge of the cornea, we avoid the ciliary ligament and body, and proceſſes; and, by directing it a little forward, in a line towards the oppoſite margin of the iris, we ſhall find the point of the needle advancing through the opaque lens; for, although the lens be ſo far opaque as to prevent the light from ſtriking the retina, it is ſo far tranſparent, in general, that the needle is diſtinctly ſeen entering its ſubſtance, and can be then directed, ſo as to transfix the cataract without hurting the iris.

We have ſeen that there is no poſterior chamber of the aqueous humor fit to contain the depreſſed criſtalline lens. The belief, which even ſome modern ſurgeons have entertained, of the poſſibility of depreſſing the lens into the aqueous humor, is a remnant of thoſe inaccurate notions reſpecting the ſize of the poſterior chamber of the aqueous humor and the place of the lens,

* In our moſt modern ſyſtem of ſurgery, we are directed to enter the needle one tenth of an inch. To my certain knowledge, not only the ciliary body has been injured by this direction, but even the root of the iris has been ſeen to be puſhed forward on the point of the needle.

which

which have long been corrected. With this, alfo, I think ought to have been forgotton, the idea of the rifing of the lens after it has been depreffed by the cataract floating in the humors.—The fact I am confident is this: when, after transfixing the cataract, we endeavour to diflodge it by depreffing the point of the needle, we feparate the adhefion between the humors and the points of the ciliary proceffes; we do not, however, unfocket the lens from the fore part of the vitreous humor, but when the lens defcends with the point of the needle, from before the pupil, the vitreous humor revolves with it; the confequence of which is, that when the needle is withdrawn, the lens rolls round with the vitreous humor: but as the lens only is opaque as its firm connexion with the vitreous humor, and even the rolling of the vitreous humor itfelf cannot be feen, this rolling of the lens appears to be the confequence merely of its own buoyancy in the aqueous humor. This adhefion of the lens to the vitreous humor, I have been fenfible of during its depreffion, from the elaftic nature of the refiftance which I felt. When the lens parts from its focket in the vitreous humor, and when it is depreffed with fuch a turn of the needle as puts it under the anterior part of the vitreous humor, it cannot rife again; there is no motion of the eye which can replace it—there is no aqueous fluid in which, if it were of lefs fpecific gravity, it could rife: it lies under and, in part, imbedded in the vitreous humor. Another idea is, that it rifes with the needle: but no one, who underftands what is to be done in the operation of the needle, will raife it again oppofite to the pupil after the

lens is depreſſed—it ought to be withdrawn without again elevating the point. But what has always appeared to me as the moſt unaccountable cauſe that can be aſſigned for the riſing of the cataract, is the action of the muſcles of the eye *. It has been explained how the lens is protruded by the action of the muſcles when the cornea is cut and the aqueous humor let out, for then the uniform reſiſtance of the eye is broken, and there is a motion of the humors towards the breach, and the lens, lying behind the pupil, is the firſt part to be protruded forward; but when it lies under the anterior part of the vitreous humor (and there it muſt lie if it is at all diſplaced), or in whatever ſituation it happens to be, from that it cannot be moved by the action of the recti muſcles; for they embrace the eye on every ſide, and their action operates uniformly, ſo that they cannot effect a body immerſed in the midſt of the humors. For the ſame reaſon that we ſhould decline the operation of extracting, after attempts have been made to depreſs with the needle, I ſhould refuſe when the pupil is rugged and irregular, becauſe the diſeaſe may be more extenſive than it appears to be. Thus cataracts brought on by falls, or blows, or punctures of the eye, are leſs favourable, as there is danger of the inflammation having gone deep, and having affected the other humors in a way which cannot be known, ſince the opaque lens is betwixt us and them.

A frequent cauſe of the failure of the operation of depreſſion is the diſplacement of the lens backwards;

* See Mr. Benjamin Bell's Syſtem of Surgery.

for

for when it ſeems to have gone down with the needle, it has ſlipped from under it and ſtarted backward. In this caſe the pupil appears clear, but the patient gains little advantage; for the cataract, though removed from the pupil, is ſtill in the ſituation to obſtruct the light.

CHAP. XI.

OF THE MANNER IN WHICH THE EYE ADAPTS ITSELF TO THE DISTANCE OF OBJECTS.

THIS is a queſtion which many have endeavoured to determine, and many have failed; the proof of which is, that there is not *one* explanation of the manner in which the eye adapts itſelf to the diſtance of objects, but *many* explanations equally ingenious.

One opinion is, that the eye is at reſt when we ſee the diſtant parts of a landſcape, but that the direction of the eye to the nearer objects is attended with an effort. This effort is the action of the ſtraight muſcles of the eye compreſſing the ball of the eye, ſo as to lengthen the axis as much as is neceſſary to allow the pencils of rays to unite in points upon the retina.

To this opinion it is objected, that in ſome animals the ſclerotic is hard, and not capable of changing its figure; that in man, the preſſure would be unequal; that the unelaſtic retina would be thrown into irregular folds; that theſe muſcles, being voluntary muſcles, under the will, we ſhould be more conſcious of their operation than we are; and that, while the mind remains attentive to diſtant objects, no voluntary exertion of theſe muſcles can effect the diſtinctneſs of the objects. Again, to make the eye change its accommodation from the diſtinct viſion of objects, at ſix inches to fourteen

fourteen feet five inches, would require ſuch a preſſure as might lengthen the axis of the eye one tenth part, which again would form an oval that would derange the retina.

Another opinion is, that when the eye ſees the neareſt objects it is at reſt; and that, in attending to diſtant objects, the ſtraight muſcles draw back the fore part of the eye into the ſocket, and thus ſhorten the axis. To this opinion, of courſe, the ſame objections lie as to the ſuppoſition that the axis is lengthened by the operation of the muſcles.

There are ſome who have entertained an opinion, that the iris, by its contraction, operates ſo on the circular margin of the cornea, where it is connected with the ſclerotic coat, as to make the cornea more convex, and thus encreaſe its power of concentrating the rays and enable the eye to ſee near objects diſtinctly. To account for this power in the iris, Dr. Jurin, the propoſer of this hypotheſis, ſuppoſes that there is a greater muſcular ring in the margin of the iris connected with the edge of the cornea: the exiſtence of theſe muſcular fibres is not demonſtrated, but he ſays, ſince the leſſer muſcular ring in the inner margin of the iris is not proved by ocular inſpection, and yet is juſtly inferred from its effects, viz. the contraction of the pupil; in the ſame way, "the change of conformation in the eye has not yet been adequately accounted for, but may be fairly made out by ſuppoſing the exiſtence of the greater muſcular ring." His concluſion is in theſe words:—
"When we view objects nearer than the diſtance of
"15 or 16 inches, I ſuppoſe the greater muſcular ring
"of the iris contracts, and thereby reduces the cornea
"to

" to a greater convexity; and when we ceafe to view " thefe near objects, this mufcular ring ceafes to act, " and the cornea, by its fpring, returns to its ufual " convexity fuited to 15 or 16 inches. In which con- " dition the elafticity of the cornea on the one fide, " and the tone of the mufcular ring on the other, " may be confidered as two antagonifts in a perfect " equilibrium."

To this opinion it is objected, that the iris is not rooted in the cornea, but in the fclerotic coat, which is firm in man and inflexible in many animals. We have alfo to confider, that this delicate and invifible circle of mufcular fibres has not only to contract the margin of the cornea, but, in this action, to alter the configuration of the whole eye. The eye-ball is a whole equally diftended, and no part of it can fuffer contraction without a refiftance from the whole of the coats: befides, in this cafe, the alternation of light and the brightnefs of objects would be perpetually obfcuring the image, by the play of the iris caufing an alteration of the focus of the cornea. But Dr. Jurin did not attribute the whole effect to the action of the iris. He thus explains the ufe of the fluid furrounding the lens and the membranous capfule:—When the eye is to be fuited to greater diftances, he fuppofed that the ligamentum ciliare contracts its longitudinal fibres, and, by that means, draws the part of the anterior furface of the capfule, into which thefe fibres are inferted, a little forward and outward. By this action, he fuppofed that the fluid, within the capfule of the lens, flows from the middle towards the margin; and, confequently, the centre of the capfule of the lens is reduced to a lefs

degree of convexity; and that the elaſticity of the capſule, and the tone of the ligament, may be looked upon as two antagoniſts perfectly in equilibrio with one another. In the ſtate of reſt, the eye is conceived, by Dr. Jurin, to be adapted to the middle diſtance; by the encreaſe of the convexity of the cornea, to be adapted to nearer viſion; and by the change in the capſule of the lens, to be fitted to diſtant objects.

To this laſt ſuppoſition it is objected, that there is a ſimplicity in the operations of nature; that the change, wrought upon the capſule of the lens, is inſufficient to account for the whole effect, and that, therefore, there is a preſumption that it has no ſhare in producing the change; that there are no muſcular fibres in the ciliary proceſſes; and, laſtly, that this fluid, being of denſity but little, if at all, removed from the aqueous humor, any alteration of its form can have but a very inſignificant effect.

It has occurred to others *, that the oblique muſcles of the eye-ball, being thrown in oppoſite directions round it, they may have the effect of elongating the axis of the eye: Again, that the action of the orbicularis muſcle of the eye-lids, by compreſſing the eye-ball, aſſiſts in accommodating the eye for ſeeing near objects more diſtinctly. Dr. Monro makes a ſet of experiments to prove the effect of the orbicularis muſcle of the eye-lids; but I conceive that he has deceived himſelf, in aſcribing to the compreſſion of the eye-lids an effect partly produced by a voluntary effort, but in a way which is not underſtood, and partly by the contraction

* Hambergerus, Briggs, Keil, Monro.

and dilatation of the pupil, from the degree of opening of the eye-lids. If he be right in his way of accounting for the effects produced in the experiments which he details, they ought to have the effect of precluding the necessity of all further hypothesis; so fully does the action of the orbicularis muscle seem to him adapted to the end proposed. In the first experiment, when he opened his eye-lids wide, and endeavoured to read a book the letters on which were so near the eye as to be indistinct, he found that he could not do it. In the second experiment, keeping the head in the same relation to the book, he brought the edges of the eye-lids within a quarter of an inch of each other, and then made an exertion to read, when he found he could see the letters and words distinctly. When I try this experiment, I find the action of the eye-lids to have no sensible effect, unless they are brought very close together: then, I do indeed find that they have a most remarkable effect. But in this situation, the eye-lids cover the cornea so much, that if they have any effect at all upon the cornea, it must be to compress and flatten it, and not to give it a greater convexity. The smaller the opening of the eye-lids, the greater I found the effect. I conceive it to be produced by the optical effect of the eye-lashes correcting the too great converging of the rays; and the same effect I found to be produced by the marginal hairs of two flat camel-hair brushes, although the eye-lids were kept open. Dr. Monro concludes that, in this action of the eye, 1st, the iris, 2dly, the recti muscles, 3dly, the two oblique muscles, and, 4thly, the orbicularis palpebrarum,

rum, have all their ſhare in accommodating it to the diſtance of objects, and in giving perfect viſion.

Very ingenious experiments are made by Dr. Young*, to determine whether there be any change in the length of the axis of the eye-ball. He conſiders it as neceſſary, to account for the power of the eye in adapting it to the diſtance of objects, that the diameter ſhould be enlarged one ſeventh; its tranſverſe diameter diminiſhed one fourteenth; and the ſemi-diameter ſhortened one thirtieth of an inch. To determine this he fixed the eye, and at the ſame time he forced in upon the ball of the eye the ring of a key, ſo as to cauſe a phantom very accurately defined to extend within the field of perfect viſion; then looking to bodies at different diſtances, he expected, if the figure of the eye was altered, that the ſpot, cauſed by the preſſure, would be altered in ſhape and dimenſions; he expected that, inſtead of an increaſe of the length of the eye's axis, the oval ſpot cauſed by the preſſure of the key, reſiſting this elongation, ſhould have ſpread over a ſpace at leaſt ten times as large as the moſt ſenſible part of the retina: but no ſuch effect took place; the power of accommodation was as extenſive as ever, and there was no perceptible change either in the ſize or in the figure of the oval ſpot. Again, he placed two candles ſo as exactly to anſwer to the extent of the termination of the optic nerve; he marked accurately the point to which the eye was directed; he then made the utmoſt change in its focal length: expecting that, if there were any elongation of the axis, the external candle

* Philoſ. Tranſ. for 1801.

would

would appear to recede outward upon the viſible ſpace: but this did not happen; the apparent place of the obſcure part was preciſely the ſame as before.

A favourite opinion of late has been, that the lens has a power of altering its degree of convexity, and thus accommodating itſelf to the diſtance of objects. As to the fibrous ſtructure of the lens, there can be no doubt: firſt it is rent by fiſſure, then ſplit into lamina, and can be finally teaſed out into fibres.

This ſtructure was firſt obſerved by Leewenhoeck: he has theſe words:—"Porro vidi corpus criſtallinum "ex tam tenuibus coacervatis conſtare ſquamis ut ubi "eas oculo dimetior, dicere cogar, plures bis millenis "ſibi invicem incumbere; ubi enim corpus criſtalli-"num ab ejus membranula ſeperaſſem, ejus adhuc "axis, ubi craſſiſſimum erat, (non enim eſt perfecte "rotundum, ſed aliquo modo planum) duas tertias "pollicis partes retinebat; ergo a centro ad circum-"ferentiam eſt tertia pollicis pars atque quoniam, ex "dimenſione mea, 600 pili lati pollicis quadrati, lon-"gitudinem conficiunt 200 pili lati pollicis tertiam "partem adæquare debent. Atque nunc video ubi "denæ ſquamæ ſunt coacervatæ, eas capilli noſtri "diametrum nondum adæquare; ergo his 10 cum "200 multiplicatis, ſequetur, ut dictum, plures 2000 "ſquamas in corpore criſtallino eſſe coacervatas. Porro "vidi ſingulas has ſquamas ex filamentis, concinno "ordine juxta ſe poſitis, conſtare adeo ut ſingulæ "ſquamulæ unum filamentum ſint craſſæ; & ut hanc "ſubſtantiam fibros eam ex qua corpus criſtallinum "conſtat ob oculos ponerem, eam, lineis in circulum "ductis quantum pote deſignavi."

The

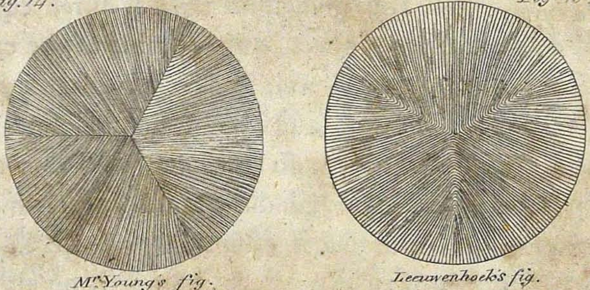
The fibrous ſtructure and muſcularity of the lens was brought forward by Deſcartes, as explaining ſome actions of the eye; but was again neglected, till more lately, that it has been revived by the inſertion of Mr. Young's obſervations on viſion in the Philoſophical Tranſactions *. The following are Mr. Young's obſervations on the appearance of the lens:—"The criſ-
" talline lens of the ox is an orbicular convex tranſ-
" parent body, compoſed of a conſiderable number
" of ſimilar coats, of which the exterior cloſely adhere
" to the interior. Each of theſe coats conſiſts of ſix
" muſcles, intermixed with a gelatinous ſubſtance,
" and attached to ſix membranous tendons. Three
" of the tendons are anterior, three poſterior; their
" length is about two thirds of the ſemidiameter of
" the coat; their arrangement is that of three equal
" and equidiſtant rays, meeting in the axis of the criſ-
" talline; one of the anterior is directed towards the
" outer angle of the eye, and one of the poſterior to-
" wards the inner angle, ſo that the poſterior are
" placed oppoſite to the middle of the interſtices of
" the anterior; and planes paſſing through each of
" the ſix, and through the axis, would mark on either
" ſurface ſix regular equidiſtant rays. The muſcular
" fibres ariſe from both ſides of each tendon; they
" diverge till they reach the greateſt circumference of
" the coat, and having paſſed it, they again converge
" till they are attached reſpectively to the ſides of the
" neareſt tendons of the oppoſite ſurface. The an-
" terior or poſterior portion of the ſix viewed to-

* See vol. for 1793.

" gether, exhibits the appearance of three penniforme-
" radiated muſcles. The anterior tendons of all the
" coats are ſituated in the ſame planes, and the poſ-
" terior ones in the continuations of theſe planes be-
" yond the axis. Such an arrangement of fibres can
" be accounted for on no other ſuppoſition than that
" of muſcularity. The maſs is incloſed in a ſtrong
" membranous capſule, to which it is looſely connected
" by minute veſſels and nerves; and the connection is
" more obſervable near its greateſt circumference.
" Between the maſs and its capſule is found a con-
" ſiderable quantity of an aqueous fluid, the liquid
" of the criſtalline."

Fibrous Structure of the Lens

Fig. 14. *Fig.*



Mr. Young's fig. *Leeuwenhoek's fig.*

Suppoſing that theſe are muſcular fibres, from their cloſeneſs and direction, they would ſtand acknowledged as forming the ſtrongeſt and moſt powerful muſcle of its ſize in the whole body; yet they act only on themſelves, which requires the leaſt poſſible degree of power. Again, how are they relaxed? What power is their antagoniſt? Mr. Young demonſtrates not only the

muſcular

muſcular fibres, but the tendons of the lens * ; as if it were not evident that the lens acted merely on itſelf, which could require no concentrating of its fibres into tendons ; for tendons are found in other parts of the body only where it is neceſſary to concentrate the whole power of the muſcle ſo as to operate on one point.

We learn from Mr. Home †, that Mr. John Hunter had proved the lens to be laminated, and thoſe laminæ to be compoſed of fibres ; and, upon the ſame authority, we learn that his opinion was in favour of the muſcularity of its ſtructure. Mr. Home wiſhed to follow out this ſubject, by including it in the Croonian Lecture. Mr. Home found, with the aſſiſtance of Mr. Ramſden, that a patient, after the extraction of the cataract, ſtill retained the power of adapting the eye to the diſtances of objects. Indeed, we muſt be well aware that if a patient, after couching and extracting the lens, could only ſee at one given diſtance, an effect ſo very particular muſt have been long ſince obſerved. This was a conviction to Mr. Home and Mr. Ramſden, that the inveſtigation was to be no further purſued in this tract, and they turned their attention, therefore, to the cornea.

Mr. Ramſden contrived an apparatus which, if the gentlemen engaged in the experiments have not deceived themſelves, muſt put this queſtion at reſt. By Mr. Ramſden's ingenious contrivance, the head was fixed accurately, and at the ſame time a microſcope was adapted to obſerve the changes in the convexity of the cornea as the eye was directed alternately to

* See Philoſ. Tranſ. † Ibid.

near and to diſtant objects. In theſe experiments, the motion of the cornea became diſtinct, its ſurface remained in a line with a wire which croſſed the glaſs of the microſcope when the eye was adjuſted to the diſtant objects, but projected conſiderably beyond it when adapted to the near ones, and the ſpace through which it moved was ſo great as readily to be meaſured by magnifying the diviſions on the ſcale, and comparing them. In this way, it was eſtimated that it moved the 800 part of an inch (a ſpace diſtinctly ſeen in a microſcope magnifying 30 times), in the change from the neareſt point of diſtinct viſion to the diſtance of 90 feet.

In the evidence from anatomical ſtructure, I cannot think Mr. Home ſo happy. He was deſirous of determining, more accurately than had hitherto been done, the preciſe inſertion of the tendons of the four ſtraight muſcles, ſo as to know whether their action could be extended to the cornea or not: he found them to approach within $\frac{1}{8}$ of the cornea before their tendons became attached to the ſclerotic coat. But he did not ſtop here—he ſtripped off with them the anterior lamina of the cornea. Now, as it is ſuppoſed, in theſe experiments, that the action of the recti muſcles upon the ſides and back part of the ball compreſſes the humors, and makes them flow forward ſo as to diſtend the cornea; if the extremities of the tendons be inſerted into the edge of the cornea and even paſs over it, as Mr. Home has demonſtrated, their effect would be to flatten the cornea, by drawing out and extending its margin. This is a circumſtance which Dr. Monro has remarked; and Dr. Monro has alſo, with more accuracy

racy of obſervation, found "all the tendinous fibres of the recti muſcles firmly attached to the ſclerotic coat at the diſtance of a quarter of an inch from the cornea, and no appearance that any part of them, or that any membrane produced by them, is continued over the cornea."

Amongſt the variety of opinions, the innumerable ingenious but contradictory experiments for diſcovering the manner in which the eye adapts itſelf to the diſtance of objects, I am, for my own part, much at a loſs to determine which I ſhould prefer. I have often doubted, whether theſe experimenters were not in ſearch of the explanation of an effect which has no exiſtence. I have never been able to determine, why a very ſlight degree of convexity in the cornea of a ſhort-ſighted eye ſhould be ſo permanent during a whole life-time, notwithſtanding the perfect elaſticity of the cornea, and its being ſo adapted as to alter its convexity by the action of the muſcles. Again, a near-ſighted perſon, with the aſſiſtance of a concave glaſs, can command the objects to the diſtance of ſome miles, and with the glaſs ſtill held to his eye, can ſee minute objects within three inches of the eye. Now, I cannot conceive how the concave glaſs ſhould give ſo great a range to the ſight: as there can be no change in the glaſs, it muſt be the eye which adapts itſelf to the variety of diſtances; yet, without the glaſs, it cannot command the perfect viſion of objects for a few feet. Again, a ſhort-ſighted perſon ſees an object diſtinctly at three inches diſtant from his eye; at 12 feet, leſs diſtinctly; and when he looks upon the object at 12 feet, the objects beyond it are confuſed, juſt as in other

men's eyes; but when he directs his attention to the more remote objects, thofe nearer become indiftinct. Now this indiftinctnefs of the object, feen when he examines narrowly the objects beyond them, would argue, (did we admit this mufcular power in the eye of adapting itfelf to objects), that the cornea or the lens has become lefs convex, were we not previoufly convinced that the utmoft powers of the eye could not bring the object at the diftance of 12 feet, or any other intermediate diftance, to be more diftinctly feen than the fixed and permanent conftitution of the eye admits.

I cannot help concluding, therefore, that the mechanifm of the eye has not fo great a power of adapting the eye to various diftances as is generally imagined, and that much of the effect attributed to mechanical power is the confequence of attention merely. An object looked upon, if not attended to, conveys no fenfation to the mind. If one eye is weaker than the other, the object of the ftronger eye alone is attended to, and the other is entirely neglected: if we look through a glafs with one eye, the vifion with the other is not attended to. Now objects, as they recede from us, become fainter and fainter in their colours, and the general effect upon the eye is different from thofe which are near; and as it happens that the mind muft affociate with the fenfation before it be perfect, there is, confequently, an obfcurity thrown over diftant objects when we contemplate near ones; as, on the other hand, the images of near ones are not attended to when the mind is occupied with diftant ones, although they be nearly in the line with the diftant object examined. I conceive it to be a good deal like that command of

the attention which we can exercise upon very small bodies near us: of two small grains lying on the table, we can examine the one and neglect the other; though, if we attend to both, we can take them in to the sphere of perfect vision; or, in other words, though they both have their images on the more sensible part of the retina. We can attend to one letter of a word, to the whole word, or to the page of a book. I cannot altogether deny the mechanical power of the eye in adapting it to the distance of objects, but I think this operation of attention has been too much overlooked.

CHAP. XII.

OF SEEING IN GENERAL.

THE eye is certainly the noblest of the organs of sense. It is that with which we should part the most unwillingly, and of which, when deprived, we are most helpless. A celebrated philosopher says, how much more noble is that faculty by which we can find our way in the pathless ocean, traverse the globe, determine its figure and dimensions, delineate every region of it; by which we can measure the planetary orbs, and make discoveries in the sphere of the fixed stars! Again, how admirable is that organ by which we can perceive the temper and dispositions, the passions and affections of our fellow creatures; and, when the tongue is taught most artfully to lie and dissemble, the hypocrisy is discovered in the countenance! we often are able to detect what is crooked in the mind as well as in the body! Yet, notwithstanding the perfection of the sense of seeing, much of this perfection is gained by the other senses, and particularly by that of touch. If the human body were motionless and inert, the sensation conveyed by the eye would be very imperfect; we should be able to conceive neither the distance nor the figure of objects. But, as it is, the distance of the object, joined with its visible magnitude, is the sign of its real magnitude; and the distance

diſtance of the ſeveral parts of an object, joined with its viſible figure, becomes a ſign of its real figure. Without this combination of the original ſenſation with the acquired perception, we ſhould ſee form and colour without having any idea of its diſtance, or of the convexity of an object; we ſhould have no meaſure of its length, or breadth, or diſtance.

Upon other occaſions, we are apt enough to acknowledge the powers of aſſociation. But the connection of ideas is in no inſtance more conſtant and ſecret than in the ideas conveyed by ſight and touch. When a ſolid body is preſented to view, we ſee only the light and ſhade; but this raiſes in our mind the aſſociated ideas from the ſenſe of touch, viz. ſolidity, convexity, and angularity, "the viſible idea exciting "in us thoſe tangeable ideas," which, in the free and promiſcuous exerciſe of our ſenſes, uſually accompany it. It is thus that we attribute to the ſenſe of ſight what is the act of the memory and judgment *.

We have ſeen that the picture of an object is formed in the bottom of the eye. It was formerly ſufficient to ſay, that the mind contemplates this image. We ſhould ſay now, that this image is conveyed into the ſenſorium by the optic nerve. This is an hypotheſis merely; and we have no more conſciouſneſs of the object being in the brain or ſenſorium than in any other part of the body: we may rather ſay, that the impreſſion made on the organ, nerves, and brain, is followed by ſenſation, and that the intelligence is the joint ope-

* See Dr. Jurin of Mr. Molyneux's problem, Smith's Append. p. 27.

ration

ration of the whole *. Laſtly, the metaphyſician calls our ſenſations the ſigns of external objects; becauſe the object itſelf is not preſented to the mind, nor is there an actual reſemblance betwixt the object and the ſenſation of it, but merely a connection eſtabliſhed by nature, as certain features are natural ſigns of anger; or by art, as articulate ſounds are the ſigns of our thoughts and purpoſes.

We are now naturally led to the conſideration of ſome points, the full comprehenſion of which, require the knowledge, both of anatomy and of the principles of optics.

PARALLEL MOTION OF THE EYES.

The axis of the eye is a line drawn through the middle of the pupil and of the criſtalline lens, and which conſequently falls upon the middle of the retina; and the axis of both eyes produced, are called the optic axis. But the axis of the eyes, it is evident, are not

* Euclid, and others of the ancients, contended that viſion was occaſioned by the emiſſion of rays from the eye to the object. He thought it more natural to ſuppoſe, that an animate ſubſtance gave out an emanation, than that the inanimate body did. In 1560, the opinion was confirmed that the rays entered the eye.—The ſenſation was not always believed to be in the retina: It was by ſome believed that part of the ſenſation was to be attributed to the criſtalline. Kepler, in 1600, ſhewed, geometrically, how the rays were refracted through all the humors of the eye, ſo as to form a diſtinct picture on the retina; and alſo he ſhowed the effect of glaſſes on the eyes. See further, regarding the opinions of the ancients, Boerhaave Prelect. Acad. tom. iv. p. 282.

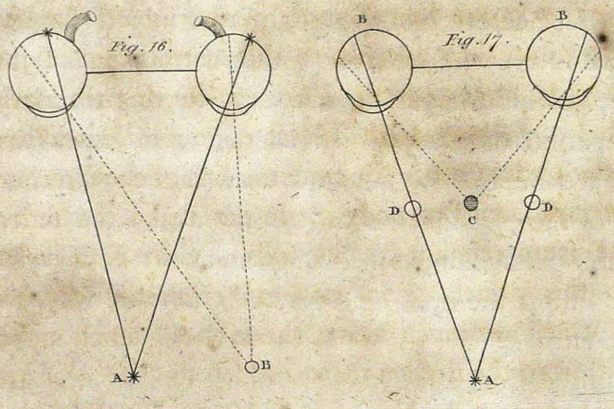
not always parallel; for when both eyes are directed to a near object, the axis of the eyes meet in that object; but when we direct the eyes to the objects in the heavens, they may be confidered as perfectly parallel in their axis, though perhaps not then mathematically fo. To an obferver, the eyes feem always moving in parallel directions; but nature has given us the power of varying them fo, that we can direct them to the fame point, whether remote or near. This, however, is in fome meafure learnt by cuftom, and loft by difufe. A child has much difficulty in altering the diftance of its eyes, which is the occafion of the vacancy of its ftare: and again, we obferve that a patient who has long loft one eye, is incapable of directing the axis of the blind eye without looking with the other, and even then, the blind organ does not follow the other with that perfect accuracy which exercife gives when both eyes are found. By much practice and ftraining, the axis of the eyes may be much further altered from the natural parallelifm, which wags and boys often do, fo as to diftort the eyes, and give a droll obliquity to the countenance.

Still, cuftom alters the direction of the axis of the eyes but a very little; for the natural conftitution of the eye does not allow the child to turn his eyes in every different direction from each other. There is, on the contrary, as we have feen, a particular fenfible fpot in the retina, which makes it neceffary to diftinct vifion, that this fpot fhall receive the concentrating rays of light; and the natural conftitution of both eyes, is, that this fpot in each eye fhall have fuch a relation to that of the other, that the axis of both

fhould

ſhould be accurately in the middle of the eye-ball in order to produce ſingle viſion.

By voluntary ſquinting or depreſſing one of the eyes with the finger, objects appear double, becauſe the optic axis is changed in the diſtorted or depreſſed eye, and the picture is no longer painted on correſponding points of both. This ſimple experiment leads us to conſider what is the conſtitution and correſpondence of the eyes, that, when each has the picture of the object impreſſed upon it, we ſhould only ſee it ſingle if the eyes are ſound and perfect.



For example, the object A, in fig. 16., is exactly in the centre of the axis of both eyes, conſequently, it is diſtinctly ſeen: and it appears ſingle, becauſe the rays from it ſtrike upon the points of the retina oppoſite to the pupils in both eyes. Thoſe points have a correſpondence; and the object, inſtead of appearing double, is only ſtrengthened, in the livelineſs of the image.

image. Again, the object B will be ſeen fainter, but ſingle, and correct in every reſpect. It will appear fainter, becauſe there is only one ſpot in each eye which poſſeſſes the degree of ſenſibility neceſſary to perfect viſion: and it will appear ſingle, the rays proceeding from it having exactly the ſame relation to the centre of the retina in both eyes. Though they do not fall on the centre of the retina, they fall on the ſame ſide of the centre in both eyes. But if the eyes are made to fix ſtedfaſtly on an object, and if another object ſhould be placed before the eyes within the angle which the axis of the two eyes make with the firſt object, it will be ſeen double, becauſe the points of the retina ſtruck by the rays proceeding from the nearer object do not correſpond in their relation to the central point of the retina. Thus, the eyes B B, fig. 17., having their axis directed to A, will ſee the object C double ſomewhere near the outline D D. Becauſe the line of the direction of the rays from that body C, do not ſtrike the retina in the ſame relation to the axis A B in both eyes. Upon this principle, we may eaſily explain why objects, which are much nearer the eyes, or much more diſtant from them than that to which the two eyes are directed, appear double. Thus, if a candle is placed at the diſtance of ten feet, and I hold my finger at arms length between my eyes and the candle, when I look at the candle, I ſee my finger double, and when I look at my finger, I ſee the candle double. This double viſion occurs to us all frequently; but, unleſs we make the experiment purpoſely, we do not attend to it. Many other inſtances of the harmony, and of the want of it in the eyes, particularly the reverſe of

what

what theſe diagrams ſhew, may be eaſily produced, viz. the ſeeing two objects ſingle: for, if we look at a halfpenny and a ſhilling, placed each at the extremity of two tubes, one exactly in the axis of one eye, and the other, in the axis of the other eye, we ſhall ſee but one piece of coin, and of a colour neither like the ſhilling nor like the halfpenny, but intermediate, as if the one were ſpread over the other.

This relation and ſympathy between the correſponding points of the two eyes, is, therefore, to be conſidered as a general fact, viz. that pictures of objects falling upon correſponding points of the two retinas, preſent the ſame appearance to the mind as if they had both fallen upon the ſame point of one retina; and pictures upon points of the two retinas which do not correſpond, and which proceed from one object, preſent to the mind the ſame apparent diſtance and poſition of two objects, as if one of thoſe pictures were carried to the point correſponding with it in the other retina.

Several animals, we ſee, direct their eyes by very different laws from thoſe which govern the motion of ours; but we are not to reaſon upon their ſenſations by the laws of viſion of the human eyes: we muſt take it as a principle, that nature has been bountiful to them alſo; and that the reſult of organization in their eyes is perfect viſion.

In birds, (if we except the owl), the eyes diverge, and are directed to oppoſite ſides. As the owl ſeeks his prey in the night, it may be neceſſary to the diſtinctneſs of his viſion in weak light, that both eyes be directed to the object. Moſt fiſhes have their eyes directed

rected latterally, though there are exceptions; as thofe fifhes which are flat, and fwim at the bottom, have their eyes directed upward. In many infects, the furface of the eye has no refemblance to the cornea of viviparous animals; but when examined with the microfcope, it is feen to confift of a number of tubercles, each of which is as a diftinct eye. In others, the eye is removed to the extremity of the moveable tenaculæ. Very large animals, as the whale, elephant, rhinoceros, hippopotamos, have, in proportion to their bodies, very fmall eyes; fo have the animals which live much under ground; and, in general, a large eye is a fign of the animal being able to fee in obfcure light, becaufe there is proportionably a greater number of rays admitted into the eye. For the fame reafon, fifhes have a peculiarly large eye and dilatable pupil, becaufe the water is a more obfcure medium, and, from the occafional roughnefs of its furface, much darkened and variable.

We muft conclude, that in thefe varieties of the eyes, where there is a difference in number, pofition, and natural motion, there are different laws of vifion adapted to thefe peculiarities and the exigencies of the animals. If we are to judge from analogy, we may fuppofe, that in many animals, there is no correfpondence between points of the two retinas, or it is of a different kind from ours. In thofe which have immoveable eyes, the centre of the two retinas will not correfpond fo as to give the idea of one object, but of diftinct objects, and in their refpective places. In other animals, correfponding points would give falfe appearances; and in fuch as turn their eyes in all di-

rections,

rections, independently of each other, they would ſeem to poſſeſs a perception of the direction in which they move them, as we have of the motion of our arms.

SQUINTING.

We have ſeen, that there is a point in both retinas more acutely ſenſible to the impreſſion of light and the image of objects, than any other part of all its concave ſurface. In a ſound eye, this point is immediately oppoſite to the pupil. There is a coincidence betwixt this point and the axis of the eye; and when we look to an object, its image ſtrikes this point of the retina: but if it ſhould happen that this ſenſible point of the retina ſhould be changed, and not be exactly oppoſite to the pupil when the axis of the eye is in the line with the object, there will be an effort of the muſcles moving the eye-ball to turn, ſo that the rays proceeding from the object ſhall ſtrike upon the more ſenſible ſpot of the nerve *. Again, if the greater ſenſibility of the nerve ſhould lie in its proper place, and a remote cauſe ſhould occaſion ſuch an action of the muſcles and diſtortion of the eye as we ſee in a ſquint, then the image will be double; for it no longer fall on correſponding points of the retina of each eye, and ſeparate images are conveyed to the brain. If, however, this diſtortion continues, the ſingle viſion is

* This was M. de la Hire's opinion.—He had an idea alſo that ſquinting was produced by the obliquity of the object. Both of theſe opinions are refuted by Dr. Jurin.

gradually

gradually reſtored. Is there, then, in this caſe produced a new correſpondence betwixt points of the retina which were before diſcordant? We find that this is not the caſe, by a very ſimple experiment.—In a perſon who ſquints, one of the eyes is directed to the object and the other appears to be turned from it: if the ſound eye be ſhut, and the perſon be directed to look to an object with the other, it is directed to it with the proper and natural axis. Now this ſhows us that the ſenſibility of the proper ſpot in the bottom of the eye is not loſt. We muſt explain the ſingle viſion in eyes, one of which is diſtorted from its natural axis, upon another principle. Moſt people who ſquint, have a defect in one eye, and this is the diſtorted eye, while the other is directed in the true axis to the object. Now the mind does not attend eaſily to two impreſſions, the one being weaker than the other: In a ſhort time the weaker impreſſion is entirely neglected, and the ſtronger only is perceived.—So in ſquinting, the impreſſion on the weak eye in a ſhort time ceaſes to be attended to, the ſtrong and vivid impreſſion is alone perceived, and ſingle viſion is the conſequence. It is evident, then, that thoſe who ſquint muſt have a degree of imperfection in the ſtrength of the image; for it is neceſſary to neglect the impreſſion of one eye, to obtain diſtinct viſion with the other; the conſequence of this is frequently an attempt ſtill further to diſtort the eye, and turn it ſo far inward or under the upper eye-lid that no diſtinct impreſſion can be received upon it: at all events, they perceive the object only with one eye, although they may be ſaid to ſee it with both; the

 perception

perception being the combined operation of the organ and of the mind.

If the ſenſation of one eye be weak, it is very liable to be neglected altogether, and that eye is apt to wander from the true axis; and if the perſon be careleſs, or given to diſtort his eyes in childiſhneſs, a permanent ſquint may be given to the eyes.

Another cauſe of ſquinting, in children, is the being ſo laid in their cradle, that the light ſtrikes obliquely into one of the eyes, whilſt the other cannot ſee it; by which means one of the eyes only comes by degrees to be directed to the light while the ſenſation of the other is diſregarded. What is very extraordinary in ſquinting, is the correſpondence in the muſcles of the eye, notwithſtanding the great diſtortion of the eye-ball; for, when both eyes are open, as the ſound eye turns in all variety of directions to the ſurrounding objects, the other eye ſtill follows it, but preſerves its diſtance, ſo as in a manner to avoid all interference. Blows on the head, drinking and ſmoaking, and a variety of irritations, occaſioning convulſions and diſtortion of the eyes, cauſe double viſion. As this is evidently produced by the affection of the muſcles moving the eye-ball*, ſince any change upon the retina could not give occaſion to ſuch diſtortions in a ſtate of inſenſibility, we may naturally conclude, that ſquinting is ſometimes the conſequence of irregular action of the muſcles; for if thoſe tranſient cauſes are apt to affect

* The command of the voluntary muſcles is firſt loſt in intoxication; and, therefore, it is more likely that the muſcles ſhould loſe their natural action and correſpondence than the retina.

affect them, so will they be apt to be permanently affected *.

We can distort our eyes by an unnatural effort, but we cannot squint: that is to say, we can bring our eyes into such a forced situation that we cannot see any thing distinctly; but we cannot keep one eye distinctly upon an object and turn the other from it.—Such a position of the eyes, at least (and which is exactly that of those who squint unintentionally), I cannot, by any means, accomplish †. This shows the strict correspondence betwixt the moving muscles of the eye-balls. By this experiment, we shall find the difficulty of that method of correcting the squint proposed by Dr. Jurin, or of commanding motions of the eyes different from those which have been bestowed by nature, or acquired by habit. But habit I believe to be much more seldom

* In Smith's Optics, there is a case of squinting and double vision occasioned by a blow. In Buffon's Dissertation, in the Acad. Roy. des Sc. 1743, squinting after long continued pain of the head. In the Mem. Roy. de l'Acad. des Sc. 1718, Hist. p. 29. there is a curious instance of false vision. I find also quoted several cases of strabismus from sudden fright, in *Ephem. Germ. cent* 3 & 4. *obs.* 152. *p.* 349. Ib. dec. 3. an. 8 & 11. ob. 57. p. 114. Ib. dec. 3. an. 9 & 10. obs. 67. "Novi Juvenem paralysi obnoxium, cui cum cæteris oculi sinistri musculis relaxatis, *adducens* fortius contraheretur propter oculum ita distortum objectum quodcunque duplex apparebat, nec quod verum esset distinguere potest." *Willis de anima Brut. P. Physiol.* p. 77. An instance of the loss of corresponding motions of the eyes, and strange illusions of sight. See in the Enquiry into the nature of mental derangement by Dr. Crichton, vol. i. p. 147.

† It is said that astronomers, who are much used to attend only to the impressions of one eye, are sometimes able to squint at pleasure. See Mr. Home Phil. Transf. 1797. p. 17.

the origin of ſquinting than is generally ſuppoſed. It is ſaid, by Dr. Reid and others, that we ſee young people, in their frolics, learn to ſquint, making their eyes either converge or diverge when they will to a very conſiderable degree: Why ſhould it be more difficult for a ſquinting perſon to learn to look ſtraight when he pleaſes? The reaſon of the greater difficulty is obvious, that in making the eyes converge or diverge the will is acting upon both eyes equally; but to diſtort one eye inward or outward, and at the ſame time to keep the other fixed, is to me like an abſolute impoſſibility. Moſt people, who ſquint, have a defect in the diſtorted eye, a weakneſs which they do not obſerve, from want of attention to the impreſſions upon that eye. It will be difficult to determine whether this defect be an original fault, or the effect of the want of uſe; ſince, by tying up the ſound eye, the weak one becomes gradually ſtronger, ſo that the perſon becomes able to read with it, much may be attributed to the neglect of impreſſions.

It may be obſerved, that this neglect of the impreſſions, which are actually received, is not at all like that diſuſe, which is the conſequence of no impreſſion being received: for darkneſs encreaſes the ſenſibility of the retina, while this diſſipates and exhauſts it. That ſquinting is not produced by the weakneſs of the impreſſion received upon the nerve, would appear from the circumſtance that opacity of the humors or the gutta ſerena do not occaſion an alteration of the uſual correſpondence in the muſcles moving the eye-balls.

It is ſaid, that in thoſe who have loſt the ſight of one eye, the habit of directing it to the object they look at

is

is loſt, becauſe this habit is no longer of uſe to them*. This I have never obſerved, nor ſhould I think it apt to happen, unleſs the muſcles of the eye had been injured from the ſame cauſe which deſtroyed the ſight; at any rate, it is in a very imperfect degree, and not ſuch as we ſhould call a ſquint.

In regard to the cure of ſquinting, it ſeems the moſt reaſonable, in the firſt place, to endeavour to ſtrengthen the weak eye by uſe, and by tying up the ſound one. In this caſe, the diſtorted eye becomes properly directed to the object, and the ſtrength of the impreſſion is in ſome degree reſtored. When this has been perſevered in for ſome time, and the perſon is allowed to look at any object with both eyes, the weak eye will perhaps be again diſtorted from the true axis; but, probably, with a painful effort and double viſion: which ſhows ſome progreſs in the recurrence of the two eyes, and their proper ſympathy, and that the impreſſion on the weak eye is at leaſt attended to. After this, it will be time enough, by Dr. Jurin's method, to endeavour to correct the ſquint:—" place the child before you, and let him cloſe the undiſtorted eye, and look at you with the other. When you find the axis of this eye fixed directly upon you, bid him endeavour to keep it in that ſituation, and open his other eye. You will now immediately ſee the diſtorted eye turn away from you towards his noſe, and the axis of the other will be pointed at you. But with patience and repeated trials he will, by degrees, be able to keep his diſtorted eye fixed upon you, at leaſt for ſome little time after the other

* Dr. Reid.

is opened. And when you have brought him to continue the axis of both eyes fixed upon you, as you ſtand directly before him, it will be time to change his poſture, and to ſet him firſt a little to one ſide of you and then to the other, and ſo to practiſe the ſame thing; and when, in all theſe ſituations, he can perfectly and readily turn the axis of both eyes towards you, the cure is effected. An adult perſon may practiſe all this with a glaſs, without any director, though not ſo eaſily as with one.—But the older he is the more patience is neceſſary. About twenty years ago, I attempted a cure, after this manner, upon a young gentleman about nine years of age, with promiſing hopes of ſucceſs; but was interrupted by his falling ill of the ſmall-pox, of which he died."

Dr. Jurin preferred this method to the uſe of tubes or ſhells with ſmall holes in them, which have been recommended. But what appears to me the great difficulty, lies in the ſtrength of the impreſſion received upon the ſound eye, which, cauſing the impreſſion of the weak eye to be entirely neglected, it is again thrown out of the line of direct viſion. I conceive it, therefore, to be a neceſſary part of the experiment with tubes or ſhells, that the viſion through the tube, applied to the ſound eye, ſhall be ſo obſcured as to have ſome accordance with the leſſer ſenſibility of the weak eye, and then, objects being ſeen equally with both eyes, a gradual accordance of the muſcles may be produced. The conviction of the neceſſity of giving an equality to the ſtrength of the ſenſation of both eyes muſt have ſtruck M. de Buffon, ſince he ſays, in his Diſſertation in the Academy of Sciences, that a plane glaſs

glaſs ſhould be applied to the weak eye and a convex one to the ſtrong eye, ſo as to reduce the laſt to a ſtate leſs capable of acting independently of the other.

But what is called a weakneſs, is very frequently, I am convinced, merely a ſhort-ſightedneſs in one eye: what the effect of this ſhould be we may experience if we look to an object with both eyes, but with one of them through a concave or convex glaſs; if we are looking upon a book, there will be produced a confuſion of the letters, but, by a little practice, the letters will become again diſtinct. By an attentive obſervation, we ſhall find that this is the conſequence of attending ſolely to the impreſſion received in the naked eye: nay, what is ſtill more ſtrange, we can attend, in this experiment, to the impreſſion upon the point of the axis of one eye, and to the general impreſſion of both. If, while looking upon the letters of a large page, I move the convex glaſs of a ſmall degree of power ſide way before my right eye, the whole letters of the page ſeem to move, leaving diſtinct and ſtationary a circular ſpot containing a word or two. Here, by no effort, while I look with both eyes, can I loſe the ſteady and diſtinct ſight of theſe few words, becauſe their image is received upon the more ſenſible central point of the retina of my left eye: but all the other part of the ſphere of viſion I can ſee alternately, dimmed or diſtinct, as I chooſe to attend to the leſs powerful impreſſion of the right eye, or the natural ſenſation of the left. We ſee, by this experiment, how eaſy it is to neglect the impreſſion of one eye, if it be no ſtronger than that of the other (and of courſe more eaſily if it be weaker), and

how impoſſible it is to neglect the more vivid impreſſion.

From ſuch a radical defect in the viſion, as the humors of one eye having a different focus from the other, and conſequently an indiſtinctneſs of viſion produced from two images of different ſizes intermingling their colours, children ſeem very frequently to be made to ſquint; and I have known adults, with a degree of the ſame inequality in the eyes, kept from ſquinting only by a particular attention to the direction of their eyes. M. de Buffon, in his Diſſertation already quoted, after affirming what has been already delivered, viz. that no one ſquints with both eyes at once, ſays, he has obſerved three inſtances in which the eyes, according to circumſtances, were alternately diſtorted from the object. This he accounts for by finding that, with one eye, the letters of a book could be ſeen at the diſtance of two or three feet, and not nearer than fifteen inches; while, with the other, the letters could be diſtinguiſhed at the diſtance of from four to fifteen inches only. Conſequently, when looking to diſtant objects, the image being more diſtinct with the long-ſighted eye, the other was turned from the object; but when objects at a ſmall diſtance were ſeen, the image in the far-ſighted eye being imperfect, it is turned from the axis, that it may not interfere with the ſtronger image of the other eye, which is now directed to the object.

A frequent effect of the weakneſs left by long fevers in children, is a ſquint which gradually goes off as the

ſtrength

ſtrength is reſtored. It is obſerved, alſo, that ſquinting and double viſion are, in ſome fevers, a concomitant with delirium and phrenitis. This ſymptom proceeds, in all likelihood, from an unequal tenſion of the muſcles of the eye-ball. The double viſion is the effect of diſcordance in the action of the muſcles.

CHAP. XIII.

OF THE EYE-LIDS, OF THEIR GLANDS, AND OF THE COURSE OF THE TEARS.

Having completed the defcription of the eye, as the organ of vifion, we have now to attend to its connections, its adventitious membranes, the glands of the eye-lids, and the courfe of the tears. It is plainly neceffary that the eye fhould not be loofe in the focket; but that, in its rolling motion, it fhould ftill be attached; and that, although the delicate anterior furface muft be expofed, the internal parts of the focket fhould be defended from the intrufion of extraneous bodies. This is accomplifhed by the tunica conjunctiva.

The TUNICA CONJUNCTIVA, or ADNATA, is the inflection of the common fkin of the eye-lids. It goes a little way back into the orbit, and is again reflected, fo as to come forward and cover the forepart of the eye-ball. Here it is pellucid, and the white coat of the eye fhines through it. It covers the cornea alfo; and here it is perfectly tranfparent; loofes its character of vafcularity, as the conjunctiva; and is affimulated to the nature of the cornea. As this coat is a continuation of the common integuments, it is, like them, vafcular, and liable to inflammation. The tunica conjunctiva, is the common feat of opthalmia. In the

the commencing inflammation, we fee the veffels turgid or blood-fhot: by and bye, they elongate towards the fuface of the cornea; the patient complains of dimnefs; the dimnefs becomes apparent to the furgeon; fpots of opacity then form in the cornea; and the veffels of the conjunctiva now take a courfe over the turbid furface of the cornea. In this ftage of the inflammation, by cutting the turgid veffels of the conjunctiva, we interrupt the fource of blood for a time, and procure a fmall evacuation; but thefe veffels foon coalefce again, and the flow of blood is renewed.

The TUNICA ALBUGINEA is the thin tendinous coat formed by the infertion of the recti mufcles, which expand over the anterior part of the eye. I would admit this into the enumeration of the coats of the eye, merely to prevent confufion of names, and to make intelligible the defcriptions of fome of the older writers. It is not properly a coat. Where the conjunctiva covers the anterior part of the eye, the white fclerotic coat is feen under it; and in confequence of this, the tunica conjunctiva is fometimes called albuginea.

A very material part of the ftructure of the eye ftill remains to be defcribed; an apparatus by which the furface of the eye is preferved from injury, kept moift, and perfectly tranfparent.

The EYE-LIDS are compofed of the common integuments, with this difference only, that they have a cartilaginous margin to give them fhape, and mufcular fibres, in the duplicature of their membrane, to give them motion. A fmall femilunar cartilage, which lies like a hoop in their edge, keeps them of a regular figure, and fo as to clofe neatly over the eye. This

cartilage

cartilage having a triangular edge, and the baſe of the angle forming the flat ſurface of the margin of the eye-lid, they meet with the moſt perfect accuracy. Either end of this hoop-like cartilage is connected with the perioſteum at the corners of the eye, ſo as to move with its fellow as upon a hinge. This cartilage of the eye-lid is called TARSUS.

The upper eye-lid only, is moved for the admiſſion of light to the eye; it is raiſed by the levator palpebræ muſcle. But the eye-lids are ſhut again by the orbicularis palpebrarum, which acts on both eye-lids, and ſometimes with ſuch power, as to ſqueeze the eye-ball even to a painful degree.

The MEIBOMEAN GLANDS. Theſe are very elegant little glands which lie under the inner membrane of the eye-lids. About twenty or thirty ducts of theſe glands open upon the tarſus of each eye-lid. Theſe ducts run up under the vaſcular membrane of the inſide of the eye-lid, and minute glandular folicules, to the amount of about twenty, are, as it were, attached to each of theſe ducts. Theſe glands exude a white ſebaceous matter, which defends the edge of the eye-lid from the acrid tears, and cloſes them more accurately by its unctuoſity. The vaſcularity of the inner ſurface of the eye-lid is ſubſervient to theſe glands; for the veſſels forming their ramifications round the little glands, ſecrete the ſebaceous matter into them. This, then, is the ſeat of the opthalmia tarſi; and following this inflammation, the edges of the eye-lids, and the mouths of the ducts, are ſometimes eroded with little ulcers. Theſe ducts are the ſeat of the ſtye. This is an inflammation and cloſing up of the mouth of one

of

of the ducts, which then ſwells up into a little hard granule in the edge of the eye-lid, accompanied with inflammation of its cyſt or ſurrounding membrane.

OF THE SECRETION AND COURSE OF THE TEARS.

THE LACHRYMAL GLAND is ſeated in the upper and outer part of the orbit, and behind the ſuperciliary ridge of the frontal bone. It is of a flattened form, and is depreſſed into a hollow of the bone. Several ducts from this gland open upon the inner ſurface of the upper eye-lid. By the reflection of the membrana conjunctiva from the eye-lid over the ſurface of the eye-ball, duſt and motes are prevented from getting behind the eye ball; and when they have got under the eye-lids, the extreme ſenſibility of the tunica conjunctiva excites the lachrymal gland, and the orbicular muſcle of the eye-lids, (which, by its preſſure, accelerates the flow of the tears), and the duſt or motes are waſhed out. The puncta for reabſorbing the tears and conveying them into the noſe, being at the inner angle or canthus of the eye-lids, we ſee the intention of the ducts of the lachrymal gland opening on the inſide of the upper eye-lid towards the outer angle: for, by this means, the tears are ſpread over all the ſurface of the eye-ball, by the motion of the eye-lids, before they decline into the puncta. But the tears do not flow only when the gland is excited by motes; their ſecretion is perpetual, and, together with the motion of the eye-lids, they perpetually moiſten the ſurface of the eye-ball. Even during ſleep they flow continually: and here we may admire a proviſion for their

their conveyance towards the inner canthus, in the inclination of the tarſus to each other; for the eye-lids meet only on the outer edge of the broad ſurface formed by the tarſus, the conſequence of which is, that a kind of gutter is formed in the angle by the inner edges of the tarſus not meeting, which leads the tears from the ducts of the lachrymal gland towards the puncta lachrymalia.

The PUNCTA LACHRYMALIA are the mouths of two ducts which form the beginning of a canal for drawing off the tears from the eye into the noſe. Theſe puncta are placed at the inner canthus of the eye, and on the termination of the tarſus of the upper and under eye-lid: they are ſurrounded by a rigid ſubſtance; and their patent mouths abſorb by capillary attraction. They lead the tears into the lachrymal ſac, and thence the tears paſs into the noſe.

The CARUNCULA LACHRYMALIS is that little granulating-like body which lies in the inner angle formed by the two eye-lids. Very ſmall hairs are ſeen to ſprout from it, and ſome ſmall ſebaceous folicles open upon its ſurface. Connected with the caruncula lachrymalis is the MEMBRANA OF VALVULA SEMILUNARIS. This is a vaſcular membrane which is drawn from under the caruncula lachrymalis by the direction of the eye outward, ſo as then to appear like a web ſpread over the white of the eye near the inner canthus. By directing the eye towards the noſe, this membrane is again accumulated about the caruncula. This, then, is a very particular mechaniſm, not as is generally deſcribed, for applying the tears to the puncta lachrymalia, but for accumulating and throwing

ing out the motes and duſt from the eye, and for guarding the puncta from the abſorption of ſuch little particles as might irritate or obſtruct them.

In birds, the valvula ſemilunaris is drawn, by a muſcle and ſmall tendon inſerted into it, quite acroſs the eye, ſo as to act like a third eye-lid; it is in them called membrana nictitans.

The LACHRYMAL SAC and DUCT lie in the os unguis or lachrymale. The ſacculus is a bag of an oblong or oval figure; it is ſunk into the foſſa of the os unguis, and defended by the frontal proceſs of the ſuperior maxillary bone; and it is covered by the ligamentous connection of the orbicularis muſcle. This ſac is the dilated upper end of the naſal duct; and into it the two canaliculi lachrymales (the extremities of which are the puncta), open as diſtinct tubes *.

Two coats are deſcribed as covering the lachrymal ſac; a nervous, white, external coat; and a vaſcular, pulpy, pituitary membrane. This ſac diminiſhing towards the lower part, and being received into the complete canal of the bone, becomes the naſal duct. Taking a courſe downward and backward, it opens into the noſe under the inferior ſpongy bone. The lachrymal ſac and duct are by ſome conceived to be muſcular, ſo as to enable them to convey the tears into the noſe; or it may be conceived, that they act like a ſyphon, the duct reaching down into the noſe acting like the long leg of the ſyphon, and drawing the tears in at the openings of the puncta. But I think it would appear, that the connections of the orbicularis

* Dr. Monro.

muſcle

muſcle over the ſac is of a nature to accelerate the paſſage of the tears, and even perfectly to compreſs the ſac. The lachrymal ſac and duct are very frequently diſeaſed and obſtructed. For example, after ſmall-pox, ſiphylis, or in ſcrophulous conſtitutions, the inner membrane of the ſac being of the nature of the pituitary membrane of the noſe, inflames, ſwells, and adheres. The conſequences of this are, firſt, a ſwelling of the lachrymal ſac in the inner angle of the eye, and a watery or weeping eye; upon preſſing the tumor, the tears, mixed with mucus, are forced back through the puncta; by and bye the ſac inflames and ſuppurates; matter is diſcharged by preſſure of the ſac: and, laſtly, it is eroded and burſts out, diſcharging the tears and matter on the cheek. This is the complete character of the fiſtula lachrymalis. While the ſac burſts outwardly, it often does further miſchief within, by making carious the thin lamina of bone in which it lies. The theory of the ancients, with regard to this diſeaſe, was that the diſeaſe was proceeding from the caries of the os unguis, and they perforated with the actual cautery, until the patient ſmelt it in the noſe! as much with the intention of remedying the caries, as to give paſſage to the tears. But it is not the bone which is the obſtruction to the perfect cure of this diſeaſe by operation, but the membranes, which cloſe again after the moſt ingenious attempts to preſerve the paſſage. The vis medicatrix, in this inſtance, ſeems not to be ſo well aware of her intereſt as ſome phyſiologiſts would inculcate. She is, here, ever at variance with the artifice of the ſurgeon.

BOOK II.

OF THE EAR.

CHAP. I.

OF SOUND, AND OF THE EAR IN GENERAL.

THE ear is that organ by which we are made ſuſceptible of the impreſſion of ſound.

Sound is the motion of elaſtic fluids, occaſioned, in general, by the vibration of ſolid bodies: and this vibration of the ſolids depends upon their elaſticity or tenſion: or ſound may be produced by the vibration and motion of the air primarily, but not without the intervention of ſolids. The human voice, for example, does not depend merely on the percuſſion of the air, but on that vibration, as combined with the tenſion and conſequent vibration of the glottis, excited by the current of air; which, again, is modified by the mouth. In the ſame manner, the ſound and variety of tone, in muſical inſtruments, depends on

 the

the joint effect of the vibrations of the solids, and of the air.

There is no body impervious to sound, or, in other words, incapable of transmitting the vibration. That sound is communicated through the medium of the air, we know from the circumstance, that a bell, when struck in a vacuum, gives out no sound: and again, from this, that the condensed state of the atmosphere affords an easier communication of sound, and conveys it to a greater distance. The velocity of the impression transmitted by the common air, is computed at 1130 feet in a second; and sound, when obstructed in its direct motion, is reflected with a velocity equal to that with which it strikes the solid body by which its progress is interrupted.

That water conveys the vibrations producing sound, has been proved by experiment. It was once the saying of naturalists, that, to suppose fishes to have the organ of hearing, would be to conceive that an organ were bestowed upon them without a possibility of its being of use. But we are assured of the fact, that, on the tinkling of a bell, fishes come to be fed *; and it was the custom for the fishermen on the coast of Britany, to force the fish into their nets by the beating of drums †, as our islanders are at present accustomed to

* Boyle.

† M. l'Abbe Nollet, Acad. R. des Sciences. Naturalists were very incredulous of the effect said to be produced by music on lobsters. Some may be so still; but we may trust the following observation of Minasius, in his Dissertation. " *Su de timpanetti dell* " *udito*

to do when the larger fiſh get entangled amongſt the rocks. We are told, that, in China, they uſe a gong for the ſame purpoſe. Theſe facts were once of importance, though more accurate obſervation has now made them ſuperfluous. The Abbe Nollet took much pains to decide the queſtion, whether water was a medium for ſound. After conſiderable preparation, and acquiring a dexterous management of himſelf in the water, (for which he takes great merit to himſelf), he found that he could hear under water the ſound of the human voice, and even diſtinguiſh converſation and muſic. The human ear being an organ imperfectly adapted to this medium of ſound, theſe experiments do not inform us of the relative powers of air and water in the tranſmiſſion of ſound. But another experiment of the Abbe Nollet proves, what indeed to me is ſufficiently evident, from the ſtructure of the ear of fiſhes, viz. that the water tranſmits a much ſtronger vibration than the air. When he ſunk under water and ſtruck together two ſtones which he held in his hands, it gave a ſhock to his ear which was inſupportable, and which was felt on all the ſurface of his body, like that ſenſation which is produced when a ſolid body held in the

" *udito ſcoperti nel Granchio Paguro.*" " Propriis obſervationibus " certior factus afferit, obſcura nocte, placidoque mari, quoties " piſcatores ardentibus ſaculis paguri in littore hærentis oculos " lucis fulgore perſtringunt, ut ſtupido, et pene præſtigiato ani- " male potiantur, ſi forte rumor aliquis ingruit. CANCRUM " illico ſe e littore ſubducere recipereque intra undas." See *Scarpa Diſquiſitiones Anatomicæ* de Auditu in Inſectis, &c.

 teeth

teeth is ſtruck by another ſolid body *. He obſerved in other experiments, that the more ſonorous the bodies ſtruck were, the leſs vivid was the impreſſion; by which it would appear, that water, though it conveys an impreſſion more ſtrongly to the ear than the air, is not equally adapted to the reſonance and variety of tone. Indeed, this is a natural conſequence of the water, a fluid of greater denſity being in cloſe contact with the ſounding body, and ſuppreſſing its vibration. In theſe facts, we ſhall find the explanation of ſome peculiarities in the ſtructure of the ears of fiſhes.

Thus, we ſee, that the vibration of a ſolid body is continued through the air and through water, until reaching the organ of hearing, it produces the ſenſation of ſound. Sound, it will be evident, is alſo communicated through ſolids. When we put the ear to one end of a log of wood of thirty feet in length, and ſtrike upon the other, we are ſenſible of the impreſſion; and when a ſolid body applied to the bones of the head, or to the teeth, is ſtruck, we are ſenſible of the noiſe †; and this is felt even by thoſe who are deaf to impreſſions conveyed through the air: indeed it is partly in this way that we are to judge whether deafneſs may be cured by operation, as depending upon ſome injury of the mechaniſm of the organ, or whether it be an incurable affection of the nerve or brain itſelf. If the ſound be perceptible when conveyed through the

* Theſe experiments were repeated by Dr. Monro. See his Book of Fiſhes.

† Perhaps we cannot call this ſound.

teeth,

teeth, or when a watch, for example, is preſſed upon the bone behind the outer ear, we are aſſured that the internal organ is unaffected; and upon enquiring farther into the caſe, we may find that the deafneſs proceeds from ſome diſeaſe of the outer tube of the ear, or of that tube which leads into the throat, and that it can be remedied.

CHAP. II.

GENERAL VIEW OF THE VARIETIES IN THE EARS OF ANIMALS *.

THERE is in the ſcale of animals a regular gradation in the perfection of the organ of hearing. But, in the human ear, we find united all the variety of apparatus for communicating the vibration to the internal organ, and along with this the moſt extenſive diſtribution of nerves in the labyrinth, or inmoſt diviſion of the ear, to receive that impreſſion.

The ultimate cauſe of this more complex ſtructure is the greater power with which man is endowed of receiving, through the ear, various impreſſions of ſimple ſounds: language, muſic, and various modifications of the ſenſe, of which the lower animals are incapable.

As, in treating of the anatomy of the eye, we do not attempt to inveſtigate the manner in which light acts upon the retina, in producing the ſenſation of colours, but endeavour merely to explain the ſtructure of the eye; to ſhow how the coats ſupport and nouriſh the

* In the following ſhort account of the comparative anatomy of the ear, although I have taken every aſſiſtance in my power from books, I have deſcribed the ſtructure, in all the examples, from my own diſſections and obſervation.

humors;

humors; how the humors are ſubſervient to the concentration of the rays of light, and aſſiſt their impulſe upon the retina: ſo, in the ſame manner, in explaining the ſtructure of the ear, we need not inveſtigate the philoſophy of ſound, nor the nature of thoſe impreſſions which are made by it on the ſenſorium through the nerves; our views are limited to the ſtructure of the ear—we have to obſerve the mechaniſm by which the ſtrength of vibrations is increaſed and conveyed inward to the ſeat of the ſenſe, and the manner in which the nerve is expanded to receive ſo delicate an impreſſion.

The method of ſtudying this ſubject, which is at once the moſt inſtructive and the moſt amuſing, is to trace the various gradations, in the perfection of the organ, through the ſeveral claſſes of animals. It is chiefly by comparing the ſtructure of the viſcera, and the organs of ſenſe in animals and in man, that comparative anatomy is uſeful in elucidating the animal œconomy. For example, in the ſtigmata and air-veſſels of inſects and worms; in the gills of fiſhes; in the ſimple cellular ſtructure of the lungs of amphibiæ; in the more complicated ſtructure of the lungs of birds; we obſerve one eſſential requiſite through the whole gradation, viz. the expoſure of the circulating fluids to the action of the air. And in this variety of conformation, we ſee the ſame effect ſo modified as to correſpond with the habits and neceſſities of the ſeveral claſſes of animals. In the ſame manner, with regard to the circulating ſyſtem, we are taught the explanation of the double heart in the human body, by tracing the variety of ſtructure through the ſeveral claſſes of

 animals;

animals; from the ſimple tube circulating the fluids of inſects, the ſingle ventricle of fiſhes and reptiles, the double auricle and perforated ventricle of amphibiæ, up to the perfect heart of the warm-blooded animal. The organs of generation, and the œconomy of the fœtus in utero, is, in the ſame degree, capable of illuſtration from comparative anatomy. But moſt eſpecially, in the ſtructure of the ear, is there much ſcope for this kind of inveſtigation. We find ſuch varieties in the ear of reptiles, fiſhes, birds, and quadrupeds, as lead us, by gradual ſteps, from the ſimpler to the more complex ſtructure.

The ſimpleſt form of the organ of hearing is that in which we find a little ſac of fluid, and on the inſide of the ſac the pulp of a nerve expanded. If an animal, having ſuch an organ, breath the air, a membrane cloſes this ſaculus on the fore part; and, by means of this membrane, the vibrations of the air are communicated to the expanſion of the nerve through the fluid of the ſac. But if the animal inhabits the water only, it has no ſuch membrane to receive the impreſſion; the organ is incaſed in bone or cartilage, and inſtead of the membrane, ſome ſmall bone or hard concreted matter is found in contact with the pulp of the nerve. The ſound, paſſing through the waters, is, in ſuch caſe, conveyed to the organ not by any particular opening, but through the bones of the head; and this concrete ſubſtance, partaking of the tremulous motion communicates the ſenſation to the nerve *.

* It is conceived by ſome that the antennæ of inſects conveys to them the vibration of bodies, and that they may be conſidered as an imperfect variety of this organ.

For

For example, in the CRAB and LOBSTER, we find a prominent bony papilla or ſhell, which is perforated with a membrane extended acroſs the perforation, and behind this membrane there is a fluid, in which the nerve is expanded, and which receives the impulſe conveyed to the membrane. In the CUTTLE-FISH, again, there is no external opening; there is merely a little ſac under the thick integuments: this ſac has in it a ſmall concretion or bone for receiving the vibration; which, in this animal, is conveyed by a more general impreſſion upon the head than in thoſe laſt mentioned; and the vibration of this looſely poiſed bone or concrete ſeems equal to the proviſion of the membrane which, in the crab, cloſes up the external opening in the perforated ſhell.

In FISHES, there is a conſiderable variety of ſtructure. Thoſe which remain perpetually under water, have not the outer membrane, nor any apparatus for ſtrengthening the firſt-received undulations of ſound. But ſuch as lie baſking on the ſurface of the water, and breathe through lungs, have an external opening—a canal leading to the membrane, and behind the membrane bones to convey the vibration to the internal parts, and theſe internal parts, the ſeat of the ſenſe, are actually as perfect as in terreſtrial animals.

In neither of the ſpecies of fiſhes, the cartilaginous nor ſpinous fiſhes, is there a proper external opening, as in animals breathing air. They receive the impulſe from the water, upon the integuments and bones of the head; but within the head, and in the ſeat of the ſenſe, they have a moſt beautiful apparatus for receiving and conveying

conveying thoſe general vibrations to the expanded nerve. There is in every ear, adapted to hearing under water, a bone or concretion, placed ſo as to vaccilate eaſily, and which is deſtined to agitate the fluid in which it is ſuſpended with a ſtronger vibration than could be produced merely by a general impulſe. Beſides this proviſion in fiſhes, there is a very elegant ſtructure for ſtill further encreaſing the ſurface deſtined to receive the impulſe, and for expoſing to that impulſe or vibration a larger proportion of the expanded nerve. It conſiſts of three ſemicircular tubes, which penetrate widely within the bones of the head. They are filled with a fluid, and have in their extremities a diviſion of the nerve which is moved or otherwiſe affected by the vibration of the fluids contained within the tubes.

There is a ſlight variety, however, in the ear of cartilaginous fiſhes. In the head of the SKATE, for example, there is under the ſkin, at the back of the head, a membrane extended acroſs a pretty regular opening. This, however, is not conſidered as the opening of the ear; but a paſſage, like a mucous duct, which is beſide it, has given occaſion to a controverſy between Profeſſors Scarpa and Monro; and it may not be out of place to enquire a little into this diſputed point.

We have ſeen that water conveys the ſound of vibrating bodies with a ſhock almoſt intolerable to the ear, and with a particular and diſtinct ſenſation over the whole body. We ſee, alſo, that, in the greater number of fiſhes, there is confeſſedly no external opening, the whole organ is placed under the ſquamous bones of the head. Yet

Yet the cartilaginous fiſhes, which are ſuppoſed to have an external ear, ſwim in the ſame element, and are in no eſſential point peculiar in their habits. And we ſhould receive with caution the account of any peculiarity in the organ of hearing of one claſs of fiſhes, which is not common to all inhabiting the ſame fluid. Such animals as occaſionally paſs from the water into the air, muſt have a membrane capable of vibrating in the air; but, even in them, it is expanded under the common integuments, and protected by them. Were it otherwiſe, when the creature plunged into the water, it would be aſſailed with that noiſe, (confounding all regular ſounds), of which man is ſenſible when he plunges under water. It appears oppoſite to the general law of nature, to ſuppoſe any ſpecies of fiſh having that ſimple and more delicate membrane, which is evidently intended to convey atmoſpheric ſounds only, while, on the other hand, creatures living in the water alone, ſhould have an organization fit to endure the ſtronger vibrations of their denſer fluid, and which would be uſeleſs and abſurd in thoſe exiſting in our atmoſphere.

When we come to examine the ear of the ſkate, we find, that what Dr. Monro conceives to be the OUTWARD ear of the fiſh*, is really, as repreſented by

* " In the upper and back part of the head of a ſkate, and in a " large fiſh weighing 150 pounds, at the diſtance nearly of one inch " from the articulation of the head, with the firſt vertebra of the " neck or atlas, two orifices, capable of admitting ſmall ſized ſtock- " ing wires at the diſtance of about an inch and a quarter from each " other,

by Dr. Scarpa, a mucous duct merely *; which does not lead into the sacculi of the vestibule and semicircular canals, as appeared to Dr. Monro; and that to suppose this would be to acknowledge the free access of air and water to the immediate seat of the organ, and to the soft pulp of the auditory nerve, a thing absurd in every view, impossible in nature, and very wide of the truth †. To me, it appears, that this narrow duct cannot be considered as the external ear; because we find in the skate a proper membrane under the thin integuments, quite unconnected with the duct, for transmitting the sound; and, upon following this mucous duct, we find it taking a circuitous course, and filled with a strong gelatinous matter; it is every where narrow, and filled with a glutinous secretion. It has no membrane stretched across it, and bears no resemblance to the external ear of any other animal.

" other, surrounded with a firm membranous ring, may be ob- " served. These are the beginnings of the Meatus Auditorii Ex- " terni." Treatise on the Ear, p. 208.

* Dr. Scarpa, speaking of this opinion of Dr. Monro, says, " qua in re vehementer sibi hallucinatus est, ostia nimirum ductuum " mucosorum, ut manifestum est, pro auris meatubus accipiens. " Etenim omnino nullum est in cartilagineis piscibus ostium auditus " extus adapertum, membranaque *fenestræ ovalis* sub communi in- " tegumento recondita jacet et cooperta."

† " Quod et absurdum est et a rei veritate quam maxime alie- " num." Vid. *Anatomicæ Disquisitiones de auditu et olfactu, auctore* A. Scarpa.

 We

We may conclude, then, that fiſhes have no external opening like terreſtrial animals; that, inſtead of this outward proviſion, they have the moveable bone within the organ. Although the cartilaginous fiſhes have a membrane extended over part of the organ, which, in the ſpinous fiſhes, is completely ſurrounded with bone, it is not to be conſidered as capable of the tremulous motions of the membrana tympani of terreſtrial animals, but may be conſidered as analogous to the membrana feneſtræ ovalis: and, ſince it lies deep under the integuments, we have no reaſon to believe that ſound is tranſmitted to the organ of hearing in fiſhes, any otherways than through the general vibration of the head.

The organ of hearing in amphibious animals, demonſtrates to us a difference in the manner in which the ſenſation is received; for they have both the outer membrane to receive the vibration of the air, and a mechaniſm of ſmall bones to convey this motion into the ſeat of the ſenſe; and they have, beſides, within the ear itſelf, a chalky concretion; a proviſion plainly intended for propagating the motion communicated through the water.

In ſerpents, birds, and quadrupeds, we ſhall hereafter trace the various gradations in the perfection of this organ. We ſhall find, that, as the animal riſes in the ſcale, the cavities and tubes of the ear are extended and varied in their form. Now, I conceive that, while the multiplied forms of the tubes and ſphericles of the internal ear afford a more expanded and ſuſceptible ſurface for receiving impreſſions, the conſonant forms of

of the parts enable them to receive a ſtronger vibration, and a more perfect and modified ſound.

A cord of a muſical inſtrument will vibrate when another in exact uniſon with it is ſtruck. The vibration communicated to the air is ſuch, as is adapted to the tenſion of the ſympathetic cord; and no other percuſſion of the air, however violent, will cauſe it to ſound. Again, the air paſſing through a tube of certain dimenſions, will not communicate to it a motion, nor call forth its ſound, while the air, paſſing in equal quantity through a tube of one degree of difference, will riſe into a full note. What holds true in regard to the uniſon of cords, is alſo true of cylinders, or even of the walls of a paſſage or room, a certain note will cauſe the reſonance of the paſſage or room, as a certain vibration will call forth the ſound of the tube of an organ; becauſe it is in all theſe inſtances neceſſary that the impulſe be adapted to the poſition of the ſurfaces and their powers of reverberation. Sound, as allied to muſic, conſiſts in the ſucceſſion, the rythm or time of its return upon the ear.

Theſe few facts illuſtrate what I mean, by ſaying, that the various forms of the internal ear of animals, as they advance in the ſcale, give additional powers to their organ. In the firſt example of the ſimple ear, where a bone vibrates on the expanded nerve, I ſhould conceive that the ſenſation were, in conſequence of this ſimple percuſſion, capable of little variety; but in animals where, beſides this ſimpler mechaniſm, there are ſemicircular canals, and more eſpecially in thoſe animals, which have ſtill a further complication of the

forms

forms of the ear, certain ſounds will be peculiarly felt in each of theſe ſeveral cavities and convolutions; and, while the ſenſation is becoming more diſtinct, by the perfection of the organ, it admits, alſo, of a greater variety of ſounds or notes: ſo that a certain ſtate of vibration will affect the ſemicircular canals, (one or all of them), and produce the ſenſation of ſound, which would not at all affect the vibration of the ſimple lapilli lying in their ſac.

CHAP. III.

DESCRIPTION OF THE ORGAN OF HEARING IN PARTICULAR ANIMALS.

IN THE LOBSTER AND CRAB.

In these animals, the structure of the ear is very simple; but it appears to me, that Professor Scarpa, in his description, has imagined to be the organ more simple than it is in nature.

In the LOBSTER, there projects from near the root of the great antenna, an osseous papilla of a peculiarly hard and friable nature. In the point of this papilla we observe a foramen, and a membrane stretched over it. This is the seat of the organ of hearing. It is described as containing a sac of a pellucid fluid, which adheres to the membrane, while the auditory nerve is expanded upon the lower surface of the sac. Now, the lobster, being an animal which can live on land as well as in water, Scarpa gives this as an instance of a structure calculated to receive the sensation of sound equally well from the water or from the atmosphere. But, from the figure I have given of the ear of this creature, it will not appear to be so exceedingly simple; while there is evidently a provision for the reception of the vibration communicated through the water, though it does not

not indeed ſtrictly reſemble that which is commonly found in the ears of fiſhes. There is ſuſpended behind the ſacculus, and in contact with the nerve, a ſmall triangular bone, which, when pulled away *, is found to hinge upon a delicate cartilage. This bone ſeems evidently intended, by its being thus ſuſpended in the neighbourhood of the PULP OF THE auditory nerve, for impreſſing upon that nerve the vibration from the water. The lobſter, then, has, like the amphibious animals, a double proviſion for receiving the communication of ſound alternately from the water or from the air †.

The ear of the CRAB differs from that of the lobſter in this, that, under the projection, there is a moveable caſe of bone, to which we ſee a ſmall antenna attached. Within this is the organ of hearing; and there is here an internal proviſion for the tranſmiſſion of ſound to the auditory nerve, which conſiſts ſimply in a few circumgyrations of a pellucid and flexible cartilage: an inſpiſſated fluid ſurrounds this gyrous cartilage, while the pale auditory nerve is expanded behind it.

OF THE EAR OF FISHES. In the heads of fiſhes, there is a cavity ſeparated by a thin vaſcular membrane from that which contains the brain. Within this cavity there is a ſacculus diſtended with a fluid, and containing a ſmall bone ‡; on the inſide of this bag, (which is called the ſacculus lapillorum), a great pro-

* See fig. 2.

† From the mucous-like tranſparency of the nerve in the lobſter, it is difficult to aſcertain its exact relation to this bone.

‡ See plate, fig. 3.

 portion

portion of the auditory nerve is expanded. In the cartilaginous fiſhes, there are three lapilli * contained in their proper capſules, and ſurrounded with a gelatinous matter †, each of the lapilli having its appropriated diviſion of the acauſtic or auditory nerve diſtributed upon it in a beautiful network.

This cavity in the head of fiſhes, reſembles the centre of the labyrinth in the human ear, and is called the veſtibule. Within the veſtibule there is a limpid fluid, interſected every where by a delicate and tranſparent cellular membrane ; and the parts within the veſtibule are ſupported in their place by this tiſſue, which is ſimilar to that which ſupports the brain in fiſhes.

Beſides this central part of the organ in fiſhes, there are departing from the veſtibule three ſemicircular cartilaginous canals ‡, within which, are extended membranous canals. Theſe membranous tubes contain a fluid diſtinct from that contained in the common cavity of the veſtibule, nor have they any communication with the ſacculi, which contain the lapilli, although they are connected with them §. Theſe cartilaginous canals are of a cylindrical form, and, being as tranſparent as the fluid with which they are ſurrounded, are not readily diſtinguiſhed in diſſection.

* In many of the ſpinous or ſquamous fiſhes, there is only one. In cartilaginous fiſhes, theſe bodies are not like bone, but like ſoft chalk. In the ſpinous fiſhes, on the other hand, they are of the ſhape of the head of a ſpear, and hard like ſtone.

† The gelatinous matter is rather before the bones, and diſtending the little ſacculi.

‡ See plate 7. fig. 3. and fig. 4. D D D.

§ So Profeſſor Scarpa aſſerts, in contradiction to others.

diffection. Each of the cartilaginous canals is dilated at one of its extremities into a little belly, which is called the ampulla.

The auditory nerve in cartilaginous fifhes * is firft divided into two fafciculi, which are again fubdivided into leffer nerves. Thefe go to the three facculi lapillorum, and to the ampullulæ of the femicircular canals. Before the divifion of the nerve peculiar to the facculus pierces it, and is finally diftributed, it forms a fingular and intricate network of filaments. The branches to the ampullulæ are raifed on a partition which is oppofed to the mouth of the cylindrical part of the tube.

In the fpinous fifhes, the three femicircular canals unite in a common belly; but in cartilaginous fifhes, the pofterior femicircular canal is diftinct from the others.

In fifhes, all the parts of the ear are filled with a matter of a gelatinous confiftence, or vifcid fluidity; and the whole facculi and femicircular canals are furrounded with fluid. That jelly is the moft fufceptible of vibration, is evident, when we fill a glafs, and allow a body to fall into it; for then the delicate vibration is communicated to the finger on the outfide of the glafs, or, by ftriking the glafs, we may obferve the tremulous motion of the jelly. The femicircular canals, it is evident, are well adapted to receive the extenfive vibrations communicated through the bones

* The fifth pair of nerves in fifh anfwers to the feventh in man; it has the fame divifion into the *portio mollis* and *dura*.

of the head, and to convey them inward to the nerve expanded in the ampulla.

From the ſimpler to the more perfect aquatic animals, we may trace ſeveral links of the chain by which nature advances towards the perfect ſtructure of the ear. We return now to obſerve, in the firſt example of terreſtrial animals, the moſt ſimple ſtate of that part of the organ which receives the ſenſation; but where the ſtructure of the receiving organ is the moſt ſimple, the mechaniſm for receiving the vibration and conveying it to the internal ear, is modified and adapted to the atmoſphere.

OF THE EAR IN REPTILES AND AMPHIBIOUS ANIMALS.

In REPTILES, which form the intermediate claſs of animals betwixt fiſhes and quadrupeds, the ear has alſo an intermediate ſtructure; in ſome individuals of this claſs the ear reſembles that of fiſhes, ſuch as we have deſcribed, while, in others, it reſembles more nearly the common ſtructure of terreſtrial animals.

In the ſalamandra aquatica, a variety of the lizard, there is a foramen ovale *, deep under the integuments. In this foramen there is a cartilage, in immediate contact with which, there is a common ſacculus lying in the cavity or veſtibule; and in this little ſac there is found a cretaceous matter: there are here, alſo, ſemi-

* This is the appropriated appellation of the opening which leads from the outer cavity of the ear, or tympanum, into the ſeat of the proper organ where the nerve is expanded.

circular

circular canals, with ampullulæ, and a common belly connecting them. In this animal, then, it is evident, the ear is ſimilar in ſtructure to that of the cartilaginous fiſhes *.

In the FROG, the outward apparatus is different, but the internal ear is ſimple †. Under the ſkin of the ſide of the head, a little behind the prominent eye, we find a large circular opening, which tends inward in a funnel-like form: and from the upper part of the circle of this meatus we find a ſmall elaſtic bone, or cartilage ſuſpended. This bone is in contact with the common integuments of the head, which are ſtretched over the little cavity. This firſt bone is placed at a right angle with a ſecond bone, and both are lodged in a proper tympanum ‡. This ſecond bone ſwells out towards its inner extremity, and is accurately applied to the foramen ovale. The foramen ovale opens into a cavity which we muſt call the veſtibule, and which, in this creature, is peculiarly large in proportion to its ſize. This veſtibule contains a ſac, upon which the nerve is expanded: it contains alſo a chalky ſoft concretion, which is of a beautiful whiteneſs, and of a

* It is ſaid by naturaliſts, that the ſalamander never has been heard to utter a cry; and as dumbneſs is in general coupled with deafneſs, it is natural to ſuppoſe it has no ears. This is to conſider the organ as ſubſervient to converſation!

† See plate, fig. 5 and 6.

‡ This tympanum, being a cavity containing air, has communication with the mouth by a tube, which we ſhall afterwards find called euſtachian tube. Several have erroneouſly deſcribed this animal as receiving ſounds through the mouth.

regular figure when firſt ſeen, but has no ſolidity *. The veſtibule here, as in all other animals, being the immediate ſeat of the ſenſe, is filled with fluid.

In SERPENTS, the mechaniſm external to the ſeat of the organ is leſs complete than in the frog. From the ſcales behind the articulation of the bone which keeps the lower jaw extended, a little column of bone † ſtretches inward and forward. This bone has its inner extremity enlarged to an oval figure, and is inſerted into the foramen ovale. This creature has no membrana tympani, nor does it appear to have ſo good a ſubſtitute as the frog: the outer extremity of the bone ſeems rather attached to the lower jaw by a cartilaginous appendage and ſmall ligament ‡. Within the ſcull, ſerpents have the little ſac, with the cretaceous matter and ſemicircular canals, united by a common belly §.

In the TURTLE, we find a proper tympanum, and by liſting the ſcaly integuments from the ſide of the head a little above the articulation of the lower jaw, we open this cavity. Through this cavity there extends a very long and ſlender bone, which, upon the outer extremity, is attached by a little elaſtic bruſh of fibres to the cartilaginous plate under the integuments, while the inner extremity is enlarged, ſo as to apply accurately to the foramen, which opens into the veſti-

* See fig. 6. D.

† Plate, fig. 7. B.

‡ See Scarpa, tab. v. fig. ix.

§ Serpents are affected by muſic; and they will raiſe and twiſt themſelves with every variety of lively motion to the pipe and tabor.

bule;

bule; and a paſſage alſo opens from the cavity of the tympanum into the fauces. In this animal, as in all which we have claſſed under the preſent diviſion, the internal ear conſiſts of a central cavity, or veſtibule, which contains a ſac with fluid, and cretaceous matter, and of three ſemicircular canals connected by a common belly. This common belly of the ſemicircular canals has no communication with the ſacculus veſtibuli which contains the cretaceous matter, further than as it lies in contact with it, and as they both lie ſurrounded by a fluid; they equally receive the impreſſion of the little bony column, the extremity of which vibrates in the foramen ovale.

There being enumerated forty or more varieties of the LACERTA or LIZARD, many of theſe have very different habits. Some of them never paſs into the water, but inhabit dry and duſty places. The lacerta agilis, or common green lizard, which is a native both of Europe and of India, is nimble, and baſks, during the hot weather, on the trunks of old trees and on dry banks; but on hearing a noiſe, it retreats quickly to its hole. It has the ſkin over the tympanum extremely thin, and ſuch as to anſwer preciſely the office of the membrane of the tympanum. So all the varieties of reptiles which, in their habits and delicacy of hearing, reſemble terreſtrial animals, have either the membrane of the tympanum or a ſkin ſo delicate as to produce the ſame effect; while thoſe, which inhabit the water, have a rough integument, or a hard ſcale, drawn over the tympanum. Beſides this, ſome have a ſmall muſcle attached to the bone, which runs acroſs the tympanum; it is like the tenſor tympani, and is an-

other ſtep towards the proper ſtructure of the terreſtrial ear.

OF THE EAR IN BIRDS.

Comparing the internal ear of birds with that of thoſe animals which we have already deſcribed, we find a very important addition. We find here the internal ear (or labyrinth, as we may now call it), conſiſting of three diviſions: the veſtibule, or middle cavity; the ſemicircular canals; and the cochlea; which laſt is an additional part, and one which we have not in the claſs of animals already deſcribed. Leading into theſe three cavities, there are two foramina: the FENESTRA ROTUNDA, and the FENESTRA OVALIS; and both theſe openings have a membrane ſtretched over them in the freſh ſtate of the parts. The firſt, the feneſtra ovalis, or foramen ovale, receives the oſſiculus auditus, which is in birds like that which we have already deſcribed in reptiles *. This oſſiculus connects the membrana tympani (which is

* Mr. Home, in his lecture on the muſcularity of the membrana tympani, (vid. Phil. Tranſ. A. 1800), ſays, in birds this membrane has no tenſor muſcle to vary its adjuſtments, but is always kept tenſe by the preſſure of the end of the ſlender bone. This is a very imperfect account of the mechaniſm of the tympanum in birds. There are two bones, or one ſmall bone with a cartilage, which lies along the membrana tympani. This elaſtic cartilage has two little tendons attached to it. Even the ſlender bone which ſtretches from the cartilage to the foramen ovale, the inner extremity of which is enlarged to fill up that hole, ſeems to have a ſmall tendon inſerted into it; but whether this be a muſcular or ligamentous connection, I am unable at preſent to ſay.

here

here of a regular form) with the veſtibule, and conveys the vibration of the atmoſphere to it.

The ſemicircular canals are here alſo three in number, and are diſtinguiſhed by the terms minor, major, and maximus; but as the major and minor coaleſce at one of their extremities, and enter the veſtibule together, the ſemicircular canals open into the veſtibule by only five foramina in place of ſix. Each of the ſemicircular canals is dilated at one extremity into an elliptical form, while the other extremity is of the natural ſize of the diameter of the tube. Theſe canals are formed of the hard ſhell of bone, and are ſurrounded with bone, having wider and more open cancelli.

In the dry ſtate of the parts, we find a cord paſſing through the ſemicircular canals, which ſome have called the ZONULÆ NERVÆ. But theſe are the membranous canals, which are contained within the bony ones, dried and ſhrunk up. Within the bony cavities of the labyrinth, there is laid a pellucid membrane, which contains a fluid, has the nerves expanded upon it, and is the true veſtibule and ſemicircular canals; while the bony caſe, which we have deſcribed, is merely the mold of theſe and the ſupport of their delicate texture *.

The COCHLEA, one of the three diviſions of the labyrinth, is but imperfect in birds, when compared

* I lately, by accident, drew out the ſacculus veſtibuli and ſemicircular canals from the bony part of the ear of a bird, and I found the membranous ſemicircular canal to conſiſt apparently of the ſame pellucid elaſtic matter with thoſe of fiſhes.

with

with that part of the organ in quadrupeds and in man. The cochlea in birds confifts merely of two cylinders, formed of cartilage, which are united toward their further extremity. While the oppofite extremities diverge, and while one of thefe cylinders opens into the veftibule, the other opens outward into the cavity of the tympanum *.

That which more than any other circumftance diftinguifhes the organ of birds from that of animals inhabiting the waters, is the want of the bone or ftony concretion in the facculus veftibuli.

* We find Mr. Home faying that the cochlea is neither abfolutely neceffary to fit the organ to be impreffed by founds communicated through the air, nor to render it what is termed a mufical ear; and that this is fufficiently proved by that part being wanting in birds, whofe organ is particularly adapted to inarticulate founds. That the cochlea is not neceffary to the communication of found through the atmofphere, we have feen from the examination of the ear of the reptiles. But fince we fee that it forms part of the labyrinth in birds, we may be led to doubt Mr. Home's conclufion.

CHAP. IV.

OF THE HUMAN EAR.

THE anatomy of the human ear will naturally be confidered under three heads: the external ear; the tympanum; and the labyrinth. The OUTWARD EAR requires no definition. From the outward ear there is a cartilaginous tube, which leads into the tympanum. The TYMPANUM is the cavity within which is placed that mechanifm of bones and mufcles which encreafes the ftrength of the vibration, and conveys it inwards to the labyrinth. The LABYRINTH is the general name of thofe intricate canals which contain the expanded nerve, and the immediate feat of the organ.

SECTION I.

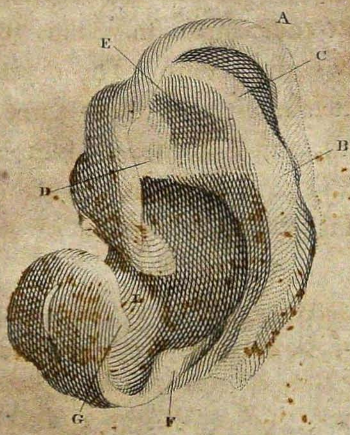
OF THE EXTERNAL EAR.

The EXTERNAL EAR is formed of an elaftic cartilage, covered with very thin integuments. The apparently irregular furfaces of the outer ear will be found, upon examination, to be fo formed that the finuofities lead gradually into each other, and finally terminate in the concha or immediate opening of the tube of the ear. By the conftant motion of the external ear of quadrupeds, we fee its importance to them, both

both in collecting ſound, and in judging of its direction. In moſt men, the motion of the ear is loſt, but ſome men ſtill retain it; and this is very remarkable, that when the more internal mechaniſm of the ear is injured, and ceaſes to ſtrengthen the ſound before it conveys it inwards to the labyrinth, the external ear reſumes the office to which it was originally adapted, and by a degree of motion and erection, aſſiſts the hearing. In Europeans, the outward ear is in a great degree flattened to the head by the dreſs; but in Eaſtern nations, and in ancient ſtatues, we ſee the ears ſtand prominent, and bear a part in the ſymmetry and expreſſion of the whole head. The muſcles moving the cartilages, beſides, being intended to give motion, appear to have a more eſſential uſe in giving a due tenſion to the outward ear. Theſe cartilages are ſurrounded with their peculiar pericondrium; but as to their veſſels and nerves, it ſeems very ſuperfluous to give a minute deſcription of them here.

When the cartilages are diſſected, they appear thus:

Fig 18



A. The

A. The HELIX. It is the outer margin, the edge of which is turned over and forms the cavitas innominata.

B C D. The ANTHELIX. It is very prominent; of a triangular ſhape; and within the outer rim or margin.

E. The SCAPHA, which is a depreſſion or cavity on the anterior part of the anthelix.

F. The TRAGUS.

G. The ANTITRAGUS. Theſe are the two prominent points which approach each other, and form the margin of the great cavity of the ear.

L. The CONCHA, or great cavity of the ear, and which is the trumpet-like opening of the meatus auditorius externus. The few pale-coloured fibres which are found on the cartilages, are ſcarcely to be recognized as muſcles *.

The LOBE of the ear, or that part which hangs down and is pierced for the ear-ring in women and ſavages, conſiſts of ſkin and cellular ſubſtance merely.

The MEATUS AUDITORIUS EXTERNUS, is the tube which leads into the tympanum. This tube is partly bony and partly cartilaginous. The outer portion of the tube is cartilaginous, and about three quarters of an inch in length, and is divided by fiſſures. The internal part of the tube is formed in the bone, as we find upon turning to the deſcription of the temporal bone.

GLANDS OF THE PASSAGE. The cuticle, covering the inſide of the tube, is very fine, and there pro-

* See Valſalva & Santorini.

ject

ject from it many ſmall hairs which ſtand acroſs the paſſage. Under this ſkin there is a ſet of ſmall glands, which pour their ſecretion into the tube, and are called the GLANDULÆ CERUMENOSÆ *. Theſe glands, ſecreting the wax of the ear, have their little ducts opening betwixt the roots of the hairs; and this ſecretion, with the hairs which ſtand acroſs the paſſage, guards the internal parts of the ear from inſects. The whole paſſage, conſiſting of the long canal of the temporal bone and the cartilaginous tube placed upon it, has an oblique direction. It firſt paſſes upward and forward, and then makes a ſlight curve to deſcend to the membrane of the tympanum.

This external tube of the ear, being of the nature of a ſecreting ſurface, and expoſed to the air, is liable to inflammation. There follows a dryneſs of the paſſages, and then a more fluid ſecretion. If the inflammation of the tube ſhould extend within the bones, then, like the affections of all parts ſurrounded with ſolid bone, the pain is extreme and the danger conſiderable: there is not only ſuppuration in the tympanum and deſtruction of the membrana tympani, but the diſeaſe may be ſtill further communicated internally. Hildanus gives us an obſervation of the effects of a ball of glaſs dropt by accident into the ear, in which

* "Hæ figuram obtinent variam: major tamen harum pars vel "ad ovalem, vel ad ſphæricam accedit colore tinguntur flavo ab "humore in earum folliculis contento qui ob aſſiduam fibrarum car-"nearum reticularium preſſionem, per cutis correſpondentia fora-"mina in meatus auditorii cavitatem tranſmittitur." Valſalva de aure humana, p. 10.

the

the inflammation was fo extenfive, and the pain fo excruciating, that the whole fide of the head and even the arms and leg of that fide were affected, in confequence of the brain partaking of the inflammation. Such things as peas and cherry-ftones and pins are very apt to be put into the ear by children; and awkard attempts to extract the foreign body, very often pufh it further in; and acrid fluids put into the ear to kill infects, have forced them deeper, with fuch an increafe of pain as has thrown the patient into a condition little fhort of delirium. A defective or too profufe fecretion from the glands of the tube, will caufe a degree of deafnefs: and fometimes the wax is fo indurated as to caufe a very obftinate deafnefs *.

In the fœtus, the concha and meatus externus are narrow, and there is fecreted a thick white ftuff, which defends the membrane of the tympanum from the contact of the waters of the amnios. This, after birth, falls out in pieces along with the fecretion of the wax; but, in fome inftances, it has remained and

* See Valfalva, p. 10. "Talis funditalis a duodecim annis affligentis curatio." The older writers treat of the "Auditus læfio a fordibus aurium lapidefcentibus." See *Bonetus*, & Jul. *Caffertus Placantinus*, "*De auditus organo*," *lib*. 1. *cap*. 20. *p*. 90. There is alfo mention made of an adventitious membrane, clofing up the paffage and ftretched above the membrana tympani. This is produced by a foul fecretion, and refembles that which ftuffs up the paffage in the fœtus. See Fabricius de Chirurg. operat. cap. de aur. Chirurg. Veslingius Anat. cap. 16. See Experiments on the folvents of the Ear-wax, by Dr. Haygarth, Med. Obf. and Inquiries, vol. iv. p. 198. He gives the preference to warm water over every other folvent.

become very hard. The deafnefs from birth, caufed by this accident, is often thought to depend upon an organic defect, and fo is neglected.

SECTION II.

OF THE TYMPANUM OR MIDDLE CAVITY OF THE EAR, AND ITS DISEASES.

THE ANATOMY OF THE TYMPANUM.

In the fœtus, the cavity of the tympanum is fuperficial, compared with that of the adult; for what forms a tube in the latter, is in the former merely a ring, which is attached to the fquamous portion of the temporal bone *: upon this circular bone the membrane of the tympanum is extended.

The cavity of the tympanum is very irregular; intermediate betwixt the membrane which is extended acrofs the bottom of the external tube and the labryinth or internal ear. It contains no fluid, as the labyrinth does; but is really a cavity, having a communication with the external air through a tube which leads into the fauces. The tympanum communicates alfo backwards with the cells of the maftoid procefs †. The inner

* See plate 8. fig. 3.

† When Valfalva, in a cafe of ulceration and caries on the maftoid procefs, threw in his injections, he found them flowing out by the mouth: viz. by the euftachean tube through the tympanum. See Val. de aure humana, p. 89.

inner extremity of the meatus externus forms a circle which is pretty regular, and upon which the membrane of the tympanum is extended. That part of the cavity of the tympanum which is oppoſite to the termination of the meatus externus, is very irregular. It has in it the foramen rotundum and the foramen ovale; and betwixt theſe, there is an irregular boney tuberoſity from which there ſtretch back ſome exceedingly ſmall ſpiculæ of bone, which connect themſelves with the margin of the irregular cavity of the maſtoid proceſs.

The FORAMEN OVALE * is in the bottom of a deep ſinus; it is not ſtrictly of an oval form, but has its lower ſide ſtraight, while the upper margin has the oval curve. This opening leads into the veſtibule or central cavity of the labyrinth.

The FORAMEN ROTUNDUM is more irregular than the oval hole. It does not look directly forward, like it, but enters on the ſide of an irregular projection: it does not lead into the veſtibule, but into one of the ſcalæ of the cochlea. In the recent ſtate of the parts, the perioſteum covering the ſurface of the cavity of the tympanum, takes away much of its irregularity. Where the tympanum leads backward into the CELLULÆ MASTOIDEA, this perioſteum is alſo continued.

THE EUSTACHEAN TUBE † extends forward from the cavity of the tympanum, and opens behind the palate ‡. In the dry bones, the euſtachean tube is

* Feneſtra ovalis.

† Iter a palato ad aurem.

‡ By ſome older writers, the euſtachean tube is called aqueduct, becauſe they conceived that tumors were evacuated from the tympanum by this paſſage.

more like an accidental fiſſure, than a regular paſſage, eſſential to the œconomy of the ear. It appears thus irregular in the bones from the tube being towards the back of the noſe, compoſed of membrane and cartilage; as the tube approaches the opening behind the palate, it widens into a trumpet ſhape; and the ſoft extremity of the tube is governed by muſcular fibres.

There can be no doubt that the euſtachean tube is deſigned for admitting the free acceſs of air into the cavity of the tympanum, that, by preſerving a due balance betwixt the atmoſphere and the air contained within the ear, the motion of the membrane of the tympanum may be free. This, at leaſt, we know, that, when the extremity of the euſtachean tube is cloſed, we ſuffer a temporary deafneſs, which can be accounted for only by the confined air wanting a due degree of elaſticity to allow the vibration of the membrane of the tympanum. I conceive it to be neceſſary, that the air in the tympanum be changed occaſionally, which is, perhaps, accompliſhed by ſome actions of the throat and fauces forcing a new body of air into the euſtachean tube. The extremity of the euſtachean tube, next to the throat, may be temporarily obſtructed by the cynanche tonſillaris, which is frequently attended with pain, ſtretching from the throat to the ear; or it may be cloſed by inflammation and adheſion of its mouth, by adheſion of the ſoft palate to the back of the fauces, by polypus in the noſe, reaching down into the fauces and compreſſing it *.

OF

* The following caſe is from Valſalva:—" Quidam plebeius " ulcus gerebat ſupra uvulam in ſiniſtra parte, quod quidem eam, " quam

OF THE MEMBRANA TYMPANI.

The membrane of the tympanum is extended over the circular opening of the bottom of the meatus externus. It has a little of an oval ſhape, and lies over ſomewhat obliquely, ſo that its lower margin is further inward than the upper. Its uſe is, to convey the vibrations or oſcillation of the atmoſphere, collected by the outer ear, inwards to the chain of bones in the tympanum. Although this membrane be tenſe, it is not ſtretched uniformly like the parchment of a drum, but is drawn into a funnel-like ſhape by the adheſion of the long proceſs of the malleus to its centre. It conſiſts of two layers of membrane, and has, naturally, no perforation in it; and the experiments of air and the ſmoke of tobacco ſent from the mouth through the ear, ſucceed only in thoſe who have had the membrane of the tympanum partially ruptured or eroded by ulceration. This membrane is tranſparent; and when we look into the tube of the ear, and direct a ſtrong light into it, we obſerve it to be of a ſhining tendinous appearance.

The inner lamina of the membrana tympani is very vaſcular. It has, indeed, been ſaid, to reſemble the iris, both in its profuſion of veſſels, and in the manner

" quam invaſerat, partem exeſerat atque abſtulerat ſic, ut ulceris
" cavitas cum extremo ſiniſtræ tubæ orificio communicaret. Igitur
" quoties homo mollem turundam remediis imbutam in ulceris
" cavitatem intrudebat; toties illico ſiniſtra aure evadebat ſurdus,
" taliſque permanebat toto ex tempore quo turunda in ulcere relin-
" quebatur:" p. 90.

of their diſtribution *. This is carrying the conceit of their analogy too far. I have obſerved an artery of a very large ſize, (compared with the ſurface to be ſupplied), running by the ſide of the long proceſs or handle of the malleus. In this courſe, it is giving out ſmall branches; and when the trunk arrives at the extreme point of the long proceſs of the malleus, it divides into two conſiderable branches, the extreme ſubdiviſions of which run towards the margin of the membrane. This artery is, nevertheleſs, too ſmall to require us particularly to avoid it in the puncturing of the membrane for deafneſs, produced by obſtruction of the euſtachean tube.

The opinions regarding the muſcularity of the membrane of the tympanum, ſhall be reſerved until we have conſidered the whole mechaniſm of the parts in the tympanum.

OF THE CHAIN OF BONES IN THE TYMPANUM.

The vibrations of the membrane of the tympanum are tranſmitted to the foramen ovale by four moveable bones; the malleus, incus, os orbiculare, and ſtapes. Theſe bones are named from their ſhape, and the names aſſiſt in conveying an idea of their form. They are ſo united by articulation and ſmall ligaments, as to form an uninterrupted chain; and, while they tranſmit the vibration, their mechaniſm is ſuch, that they ſtrengthen the impulſe. They have alſo ſmall muſcles

* See Mr. Home's lecture on the ſtructure and uſe of the membrana tympani. Phil. Tranſact. Part I. 1800.

attached

attached to them, by which it is probable, the whole apparatus has a power of adapting the degree of tenfion to the force of the impulfe communicated to the membrane of the tympanum. I conceive that they encreafe the power of the ear for receiving the weaker founds, and are, at the fame time, a guard to the internal parts, from fuch violent fhocks as might injure the nerve.

How neceffary it fometimes is to damp and fuffocate, in fome degree, piercing founds, we muft all be fenfible: and in thofe who are habitually expofed to the fudden eruption of found, the fufceptibility of the nerve is injured, and they become very deaf. We have, in a late publication, an example of this in blackfmiths, in whom, it is common to find a degree of deafnefs; and we frequently find old artillery-men quite deaf, from the long practice of their profeffion.

The malleus * receives its name from a refemblance to a hammer or mallet: it is, in fome degree, like a bludgeon; the great head ftands obliquely off from the body of the bone, (if fuch it may be called), like the head of the thigh-bone. Anatomifts can fcarcely be blamed, if, in defcribing the proceffes of this bone, they forget the body. I fhould confider that part as the body of the bone which ftretches down from the circular margin of the tympanum, and is attached to the membrane, or what we fhould confider as the handle of the mallet. This part of the bone ftands at an angle with the head and neck; tapers towards the extremity, and is a little curved down

* See plate 9. fig. 1. A.

towards the membrane. From the larger end of the body of the bone there ſtands out an acute proceſs; and from the neck attaching the bulbous head to the body of the bone, there ſtands out a very ſlender proceſs, which is often broken off. The great head of the bone does not form a regular ball to be ſocketed in the body of the incus; there are irregularities in the contiguous ſurfaces of both the bones.

THE INCUS * is the ſecond bone of the chain; it receives its name from its reſemblance to the blackſmiths anvil. It more reſembles a tooth with two roots. On the ſurface of the body, it has a depreſſion like the ſurface of the firſt molaris. Into this depreſſion of the incus the head of the malleus is received. The ſhorter of the two proceſſes, and the body of the bone lie on the margin of the circular opening of the tympanum; and the acute point of this proceſs is turned back into the opening of the maſtoid cells. The long leg or proceſs of the incus hangs down free into the tympanum †, and has attached to its point the os orbiculare.

The OS ORBICULARE is like a grain of ſand, and is the ſmalleſt bone of the body: it is a medium of articulation betwixt the incus and ſtapes.

THE STAPES ‡ or ſtirrup is well named, for it has a very cloſe reſemblance to a ſtirrup-iron; the little head is articulated with the os orbiculare: the arch of the bone is exactly like that of the ſtirrup-iron, but elegantly grooved within, ſo as to give lightneſs to the bone. The baſe anſwering to that part of the ſtirrup-

* See plate 9. fig. 1. B. † See plate 4. fig. 1. D.
‡ See plate 9. fig. 1. C.

iron

iron upon which the foot reſts, is not perforated, nor is it of a regular form, but is flat on one ſide, correſponding with the foramen ovale. It is this baſe of the bone which is attached to the membrane ſtretched over the foramen ovale.

CONNECTION AND MOTION OF THESE BONES.

The malleus hanging on that part which we have called the neck of the bone, has the long handle or body of the bone ſtretched down upon the membrane of the tympanum. It is, conſequently, deſtined to receive the oſcilations of that membrane.

The head of the malleus is ſo articulated with the incus, that the degree of motion communicated to that bone is much encreaſed.

From this ſcheme, we ſee, that the head of the malleus is ſo articulated with the body of the incus, that the centre of motion of the incus is in a line drawn

drawn through the centre of its body, and, consequently, that the extremity of the long procefs, to which we fee the os orbiculare and ftapes attached, moves through a greater fpace than that which receives the impulfe of the head of the malleus. Thus, a very fmall degree of motion communicated by the head of the malleus to the body of the incus, muft be greatly encreafed in the extremity of the long procefs of the incus, and, confequently, this mechanifm of the bones effentially affifts in giving ftrength to the vibration which is tranfmitted inward to the feat of the nerve.

The os orbiculare ftands fimply as a link of communication betwixt the extremity of the incus and the upper part of the ftapes, and its ufe is evidently to promote the accurate and perpendicular motion of this long lever of the incus upon the head of the ftapes: for, if this bone had not been fo placed, the motion of the long lever of the incus muft have given an obliquity to the impulfe upon the ftapes. The bafe of the ftapes almoft completely fills up the foramen ovale. It is feated on a membrane which is ftretched over the foramen *. The ftapes, then, acts like a pifton on a membrane of much lefs circumference than that of the membrana tympani. From all which confiderations, we may learn how much, and how ftrongly, the agitation of the air in the outer canal of the ear is en-

* Valfalva has the following obfervation; fee page 24. "Olim "namque in cujufdam furdi cadavere furditatis caufam in eo fitam "inveni nempe quod indicata membrana in fubftantiam offeam in-"durata, unum continuatum os conftituebat cum bafi ftapedis et "margine feneftræ ovalis."

creafed,

creaſed, before it ſtrikes upon the fluids of the labyrinth.

OF THE MUSCLES WITHIN THE TYMPANUM *.

The laxator tympani runs in a fiſſure of the temporal bone on the outſide of the euſtachean tube, and is inſerted into the long proceſs of the malleus. THE TENSOR TYMPANI † runs alſo by the ſide of the euſtachean tube; it is inſerted into the body of the malleus; it is a long and ſlender muſcle. The external or ſuperior ‡ muſcle of the malleus, which is denied by ſome anatomiſts to be of the nature of muſcle, comes down from the upper part of the tympanum, and is fixed by a ſmall tendon to the neck of the malleus.

THE STAPEDIUS || is the ſmalleſt muſcle, and is attached to the ſmalleſt bone. It has a ſmall round fleſhy belly, taking its origin from the rough ſide of the tympanum, and is inſerted by a ſmall round tendon into the head of the ſtapes.

As all theſe muſcles are inſerted either into the malleus or ſtapes, and not into the middle bone, it would appear that their operation is chiefly upon the membranes of the tympanum, and of the foramen ovale, through the medium of the bone immediately attached to them.

* Muſculus proceſſus minimi mallei. Valſalva.

† Muſculus proceſſus majoris mallei.

‡ Muſculus proceſſus minoris. Valſalva.

|| This muſcle is particularly ſtrong in the horſe, where it was firſt diſcovered by Caſſerius.

Mr.

Mr. Home, in the Philoſophical Tranſactions for 1800, aſſerts, that the membrana tympani is muſcular; that its fibres run from the circumference towards the centre; and that they are attached to the malleus.

But, what is the ſuppoſed uſe of this muſcular membrane? Mr. Home ſays, it is principally by means of this muſcle that accurate perceptions of ſound are communicated to the internal organ; that it is by means of this muſcle that the membrana tympani is enabled to vary its degree of tenſion, ſo as to receive the vibrations in the quick ſucceſſion in which they are conveyed to it. But we have ſeen, that the tenſion and relaxation of the membrana tympani is already ſufficiently provided; for "the malleus has three "muſcles by which it is moved; one of them is called "the tenſor, from its pulling the malleus inward and "tightening the membrane of the tympanum; the "other two act in an oppoſite direction, and relax the "membrane *". We ſhould naturally ſuppoſe this to be ſufficient; but, according to Mr. Home, theſe muſcles act only to bring the membrane into ſuch a degree of tenſion, as to enable the minuter changes of the muſcular membrane to have their full effect; and that the play of theſe muſcles gives the perception of grave and acute tones.

But the more favourite idea of Mr. Home is, that, upon the accurate adjuſtment of the membrana tympani, the difference between a muſical ear, and one which is too imperfect to diſtinguiſh the different notes in muſic, depends; that this judgment or taſte

* Mr. Home's Lecture.

is

is owing to the greater or lefs degree of nicety with which the mufcles of the malleus render the mufcular membrane capable of being truly adjufted; if the tenfion be perfect, all the vibrations produced by the action of the radiated mufcle will be equally correct, and the ear truly mufical.

Mr. Home proceeds upon the idea, that the membrane of the tympanum is like a mufical inftrument, or, as he expreffes himfelf, like a monochord; but he is fundamentally wrong in fuppofing, that it requires a more delicate organ to be perceptible of mufical tones than of articulate founds or language.

In the firft place, we may require an explanation of the ufe of that mufcle which is inferted into the ftapes. This ftapedius mufcle would feem to have the fame ufe, and to affect that bone in the fame manner, in which the mufcles of the malleus affect it. Surely Mr. Home will not go fo far as to fay, that the membrana feneftræ ovalis is alfo mufcular. It may be further worthy of attention, in confidering this fubject, that whatever affects the membrane of the tympanum, affects, alfo, the membrane of the veftibule; that, if the one be relaxed, the other is rendered tenfe, from the clofe connection that exifts between them through the chain of bones.

In the paper already quoted, the following cafe is given, as illuftrating the manner in which the lofs of the natural action of the mufcles affects the ear, in regard to its capacity for mufic. A gentleman, thirty-three years of age, who poffeffed a very correct ear, fo as to be capable of finging in concert, though he had never learned mufic, was fuddenly feized with a

giddinefs

giddineſs in the head, and a ſlight degree of numbneſs in the right ſide and arm. Theſe feelings went off in a few hours, but on the third day returned; and for ſeveral weeks he had returns of the ſame ſenſations. It was ſoon diſcovered that he had loſt his muſical ear; he could neither ſing a note in tune, nor in the ſmalleſt degree perceive harmony in the performance of others. For ſome time, he himſelf thought he had become a little deaf, but his medical attendant was not ſenſible of this in converſation. Upon going into the country, he derived great benefit from exerciſe and ſea-bathing.

In this caſe, continues Mr. Home, there appeared to be ſome affection of the brain, which had diminiſhed the action of the tenſor muſcles of the membrana tympani, through the medium of the nerve which regulates their actions; this gradually went off, and they recovered their action.

Another caſe is given of a young lady who was ſeized with a phrenzy which laſted ſeveral years, when, from being without a muſical ear, ſhe came to ſing with tolerable correctneſs, to the aſtoniſhment of her friends.

Now, to me, the ſymptoms of both caſes argue an affection of the brain, and of the nerves. It is more probable that the delicate auditory nerve ſhould be affected in ſuch a diſeaſe, than that the portio dura ſhould alone be affected.

We now proceed to put the incorrectneſs of this reaſoning concerning the muſcular power of the membrane of the tympanum, in a more particular point of view. Mr. Cooper was led to pay particular attention

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to the action of the membrane of the tympanum, from being consulted in a case where the membrane was lost with little injury to the function of the organ *. He found, that, instead of the total annihilation of the powers of the organ, the gentleman was capable of hearing whatever was said in company, although the membrane of both ears was destroyed. He could even hear better in the ear in which no traces of the

* Case. This gentleman had been attacked at the age of ten years, with an inflammation and suppuration in his left ear, which continued discharging matter for several weeks: in the space of about twelve months after the first attack, symptoms of a similar kind took place in the right ear, from which matter issued for a considerable time. The discharge, in each instance, was thin, and extremely offensive to the smell; and in the matter, bones, or pieces of bones, were observable. The immediate consequence of these attacks was a total deafness, which continued for three months; the hearing then began to return; and, in about ten months from the last attack, was restored to the state in which it at present remains. Having filled his mouth with air, he closed the nostrils, and contracted the cheeks; the air thus compressed, was heard to rush through the meatus auditorius with a whistling noise, and the hair hanging from the temples became agitated by the current of air which issued from the ear. When a candle was applied, the flame was agitated in a similar manner.

Mr. Cooper than passed a probe into each ear, and he thought the membrane on the left side was entirely destroyed, since the probe struck against the petrous portion of the temporal bone. The space usually occupied by the membrana tympani, was found to be an aperture without one trace of membrane remaining. On the right side, also, a probe could be passed into the cavity of the tympanum; but here, by conducting it along the sides of the meatus, some remains of the circumference of the membrane could be discovered, with a circular opening in the centre, about the fourth of an inch in diameter. See Trans. Roy. Soc. for 1800, Part I. p. 151.

membrane

membrane remained. This gentleman was only in a ſmall degree deaf from the loſs of the membrane; but his ear remained nicely ſuſceptible of muſical tones, "for he played well on the flute, and had frequently "borne a part in a concert; and he ſung with much "taſte, and perfectly in tune." This caſe puts aſide, at once, that theory which ſuppoſes the muſical ear to depend on the minute play of the muſcles of the tympanum.

It appears, then, that the membrane of the tympanum may be deſtroyed, that the bones may be waſhed out by matter formed in the tympanum, and ſtill the patient retain the uſe of the organ. But this is only while the ſtapes retains its place; for, if this bone be alſo deſtroyed, the membrane of the foramen ovale will be deſtroyed, and the fluids of the labyrinth be allowed to flow out, or be otherwiſe loſt. We ſee, that, if the chain of bones, and only a part of the membrana tympani be left, ſtill this ſhred of membrane, if it be not detached from the handle of the malleus, will vibrate in the air, and communicate thoſe vibrations through the other bones to the veſtibule. We ſee, alſo, that though the bones only remain, and though they be detached from the membrane of the tympanum, the ſound will ſtill be communicated. We ſee, that a rupture of the membrane will not deſtroy the organization ſo far as to prevent the hearing, unleſs there follow clots of blood or inflammation, ſuppuration, or fungus. When Mr. Cooper found that the membrana tympani could be torn without injuring the organ, he did not ſtop ſhort in his inveſtigation: but as he found, by daily experience, that obſtruction of

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the euſtachean tube cauſed deafneſs, he thought of punƈturing the membrana tympani, as a cure for that kind of deafneſs. He expeƈted, by this operation, to give elaſticity to the confined air. Accordingly, by punƈturing the membrane of the tympanum with a ſmall trocar, he found, with much ſatisfaƈtion, that the hearing was inſtantly reſtored *.

Valſalva made a good diſtinƈtion, when he ſaid, that the membrane of the tympanum was not abſolutely neceſſary to hearing, but only, to perfeƈt hearing. We have, in this faƈt, the explanation of the following circumſtance, amongſt many others: "In naturali "ſurditate a conformationis vitio inter tandum iſtud "experimentum, (viz. an oſſiculi et membrana tym-"pani aliquis ſit uſus auditum), quod inopinato et "feliciter ſucceſſit cuidam, qui intruſo auri ſcalpio in "aurem profundiſſime diſrupit tympanum, fregitque "oſſicula et audivit." *Biolanus Encherid. Anat. lib.* 4. *c.* 4. See alſo *Bonetus de Aurium Affeƈt. Obſerv.* IV. Willis alſo knew, that the deſtruƈtion of the membrana tympani did not deprive the perſon of hearing. *Vid. de Anima Brutorum.*

§ 2. OF THE DISEASES OF THE TYMPANUM.

Valſalva denied the exiſtence of perioſteum to theſe bones of the tympanum, while he allowed that they

* I am only afraid that ſuch punƈtures will not continue open, as in Valſalva's experiments they healed up very ſoon. But, when there is no other ingreſs and eſcape to the air in the tympanum, but through the punƈtured hole, it may tend to keep it open.

had

had minute veſſels diſtributed on their ſurfaces: but theſe veſſels he ſuppoſed to creep along the naked bone independently of any membrane. This, however, is contrary to all analogy. Theſe bones, as well as the cavity of the tympanum, are covered with a very fine membrane or perioſteum, which, after a minute injection, is ſeen covered with many ſmall and diſtinct veſſels, as well as with intermediate extravaſcular effuſions of the injection, as happens in injecting in other membranes.

When the tympanum becomes diſeaſed, there is fetid matter collected, the membrane of the tympanum ſuffers, and the ſmall bones are ſometimes diſcharged. In ſuch a caſe, we have little farther to do than, by injections, to prevent the matter from accumulating. But, let us not confound this ſerious cauſe of deafneſs with the ſlighter ſuppurations in the outer paſſage of the tube: although ſuch ſuppurations in the tube of the ear are apt, when neglected, to deſtroy the membrane of the drum or tympanum, and to ſpread diſeaſe to theſe internal parts.

Authors make a diſplay of the diſeaſes of the membrane of the tympanum under the titles relaxatio, tenſio, nimia, induratio, and diruptio tympani *. We have ſeen how little rupture of the membrane affects the hearing, and may thence conclude, that theſe fantaſtic imaginings about tenſion and relaxation of the membrane deſerve little notice. The idea of relaxation of the membrane of the tympanum, I have no doubt, has ariſen from the effect of cold and moiſt

* See Du Verney de Organo Auditus, p. 41.

weather

weather in injuring the hearing; but deafnefs from this caufe is not produced by relaxation of the membrane of the tympanum, but by fwelling of the mouth of the euftachean tube *.

Induration of the membrane is lefs of an imaginary difeafe, fince there are inftances of the membrane becoming thickened by inflammation, or cartilaginous, or offeous. The membrana tympani has been found to adhere to the extremity of the incus †. Independently of the want of elafticity, which fuch an adhefion muft produce, the mechanical effects, the vibration of the bones, is prevented, and a degree of deafnefs is inevitable.

Fungous or polypous excrefcences from the glands in the outer paffage of the ear, prefs back and deftroy the membrane of the tympanum. In the cure of thefe by the knife, cauftic, or ligature, there is much danger of injuring the membrane. Fungous tumors project from the membrane itfelf. A ftroke upon the head will caufe bleeding from the ear. This is often a fign of concuffion of the brain; that is to fay, a fhock fo fevere as to rupture the membrane of the

* "Relaxatio fit ab humore fuperfluo qui membranam hanc "humectat et fymptoma hoc communiter cum obftructione meatus ex tumore glandularum conjunctum eft, de qua jam fupra "dictum eft: multum autem facit ad difficultatem audiendi in perfonis quæ defluxionibus catarrhofis obnoxiæ funt et per eandem "rationem auftri nebulæ et aer pluvius auditum minuunt ut experiri "quotidie poffumus." Du Verney loc. cit. p. 41.

† See the London Philofophical Tranfactions for 1800, Part I. p. 5.

tympanum, will moſt probably injure the brain *, after bleeding from the ear. Sometimes ſuppuration follows †; and blood flowing thus from the membrane of the tympanum, or other part of the ear, runs back into the cavity of the tympanum, and, filling it with coagulum, cauſes deafneſs, by obſtructing the free motion of the bones and membrane. Mr. Cooper, in a caſe of this kind, punctured the membrane, and, after a diſcharge of blood which continued for ten days, the hearing was gradually reſtored. It is ſuppoſed by that gentleman, that the blood effuſed becomes, in ſome inſtances, organized, ſo as to obliterate the tympanum cauſing permanent deafneſs. I think it is more likely that the blood has, in ſuch caſes, deſtroyed the mechaniſm by ſuppuration.

The danger in ſuppuration and caries of the tympanum is, that the diſeaſe may penetrate backward into the maſtoid cells and labyrinth, or into the brain itſelf; for inflammation and ſuppuration ſo confined amongſt the deep receſſes of the bone, muſt give great torture, and be apt to extend the miſchief to the brain, or throw out matter on the inſide of the cranium, the effect of which muſt be mortal. Such, I think, I have ſeen to be nearly the effect of ſuppuration deep in the ear. In a man who had been deaf for many years, and who was killed by a fracture of the ſkull, I found the cells of the temporal bones filled with matter, and

* When Valſalva found the ventricles of the brain full of blood, and blood alſo in the tympanum, he ſuppoſed that the blood in the latter was derived from the brain through certain foramina which he diſcovered. See p. 30.

† See Valſalva, p. 16.

a thin

a thin greenifh fluid lay betwixt the temporal bone and dura mater.

Valfalva gives us a cafe of injury of the head, in which the patient was relieved while the difcharge of pus by the ear was free; but he died when it was entirely fuppreffed *.

But, after fuch fuppuration as we fhould naturally think muft totally deftroy fo delicate an organization, we are fometimes agreeably furprifed with a gradual recovery of the function. This is owing to the nerve accommodating itfelf, or becoming fenfible to a lefs forcible impreffion, and by the ear acquiring new properties. I already mentioned, that the deftruction of the mechanifm of the tympanum arofe fometimes from fuppurations beginning in the outward ear; and we may fuppofe that the apparatus within the tympanum, when partially hurt, is fometimes capable of being, in fome degree, replaced by a natural procefs; of which, the following cafe from Valfalva is a remarkable proof.

" I lately examined the ears of a woman whofe hearing had been much injured by an ulcer of the tympanum and caries of the fmall bone. I found the ear in which fhe was deaf without a membrana tympani, and the ftapes only remaining of the bones, and a fibrous mafs, like an excrefcence, in the tympanum.

* Valfalva, p. 83. See alfo a cafe in Bonetus de Aurium Affect. Obferv. I., and Gul. Ballonius Epid. et Ephem. lib. 2. p. 270. When the matter was fuppreffed, there came pain of the head, and weight, which yielded to no remedy; on diffection, there was found an abfcefs within the fkull. In Bonetus loc. cit., a cafe is related, in which an ignorant furgeon compreffed a fiftulous ulcer in the ear, and fo caufed the death of the patient.

But, in the tympanum of the oppoſite ear, I found the membrana tympani almoſt entirely eroded; ſo that the malleus and incus were uncovered, and diſtinctly ſeen. I could even obſerve, that the long proceſs of the incus, which ſhould be articulated with the head of the ſtapes, was ſeparated from it: but nature had curiouſly reſtored the eroded membrane. Thus, from the edge of the injured membrane, a new membrana tympani was obliquely ſtretched acroſs the cavity of the tympanum, ſo as to exclude the malleus and incus from that cavity, but including the head of the ſtapes, as if nature, finding the ſeparated bones no longer neceſſary, had attached the membrane to the head of the ſtapes *. We have already remarked, that, when the organ of one ſide is injured, we hear ſo much better with the other, that we attend only to the ſenſation conveyed by it, and neglect the duller ſenſation. The conſequence of this, is, that the bad ear becomes worſe. It is much like that effect which takes place in eyes by ſquinting.

SECTION III.

OF THE LABYRINTH.

The labyrinth is the internal ear; the proper ſeat of the ſenſe of hearing. It conſiſts of the veſtibule or middle cavity; of the ſemicircular canals; and of the cochlea.

* See Valſalva de Aure Humana Tract. p. 79. In thoſe deaf from birth, it has been twice found that the *incus* was wanting. See *Bonetus de Aur. Affect. Obſerv.* IV.

cochlea. It has its name from thofe cavities and tubes leading into each other in fo intricate a manner, as to be followed out with much difficulty.

We underftand that the cavities hitherto defcribed in the human ear contain air, and communicate with the atmofphere: but, in the cavities we have now to defcribe, the nerve is expanded, and there is, in contact with it, not air, but an aqueous fluid. In treating of this divifion of our fubject, we have, firft, to attend to the forms of the cavities, as feen when fections are made in the dry bones next to the foft parts contained in thofe cavities; and, finally, to the diftribution of the nerves. To give an idea of the exquifitely delicate and complex ftructure of the many canals, excavations, openings, fulci and foveæ, of the bones; of the tubuli, facculi, and partitions of the membranes; and, laftly, of the foft expanfions of the nerves, without the affiftance of plates, would be impoffible. Albinus, in his academical annotations, begins very formally a chapter on the ear; but, after a few words, difmiffes the fubject, referring merely to his plates.

THE VESTIBULE, or central cavity of the labyrinth, is of an oval form, and about a line and a half in diameter *. It has two remarkable pits or hollows in it, and has numerous foramina opening from it into the neighbouring cavities, befides leffer foramina for tranfmitting that portion of the nerve which is diftributed on the facs contained in it. One depreffion or fovea is in the back and lower part of the veftibule, another in the outer and fuperior part of it: the one is

* Du Verney Œuvres Anatomiques.

 circular,

circular, the other ſemi-oval. Morgagni, and other anatomiſts, examining the dry bones, ſpeculated on their uſe in reverberating the ſound in the cavity ; but we muſt not regard them in this unnatural ſtate: on the contrary, they contain in the living ſubjects membranous ſacculi filled with fluid, and have the nerve expanded upon them. That foramen over which the ſtapes is placed, and which is called the foramen ovale, tranſmits the vibration into the veſtibule. For the foramen ovale opens directly into the veſtibule, and through the veſtibule, only, does the vibration of the bones in the tympanum reach the other parts of the labyrinth.

Semicircular canals. When we have cut into the veſtibule, by taking away that portion of the os petroſum which is behind the meatus auditorius internus, we ſee five circular foramina : theſe are the openings of the ſemicircular canals. There are three ſemicircular canals ; and they are diſtinguiſhed by the terms, the ſuperior or vertical, the poſterior or oblique, and the exterior or horizontal. The one which, in this view, is neareſt, is the opening common to the inner ends of the poſterior and ſuperior ſemicircular canals. When we paſs a briſtle into this common foramen, and direct it upward, it paſſes along the ſuperior ſemicircular canal, and will be ſeen to deſcend from the upper part or roof of the veſtibule, almoſt perpendicularly on the foramen ovale, which is open, and immediately oppoſite. If, again, we paſs a briſtle into the foramen which is near the bottom of the cavity, (and which will be juſt upon the edge of the fracture that has laid open the veſtibule, if not included in it), it will come out by the opening common to the

ſuperior and poſterior ſemicircular canal. It has paſſed, then, along the poſterior canal. The two openings of the exterior or horizontal canal are upon the back part of the veſtibule; and the canal itſelf takes a circle which brings its convexity to the confines of the maſtoid cells. Theſe canals are formed of a very hard brittle bone, their caliber is ſo ſmall as not to admit the head of a common pin; they form ſomewhat more than a half circle; and of each of them, one of the extremities is enlarged like the ampulula of fiſhes. Valſalva imagined that the enlarged extremities of theſe tubes were trumpet-like, to concentrate and ſtrengthen weak ſounds. We ſhall find, on the contrary, that there is in the human ear, as in fiſhes, a particular expanſion of the nerve in theſe extremities of the tube, oppoſed to the circulatory vibration of the fluids in the canals.

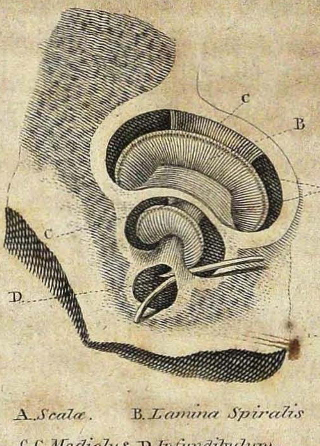
The cochlea. The third diviſion of the labyrinth is the cochlea. It is ſo named from its reſemblance to the ſhell of a ſnail, or from the manner in which its ſpiral lamina turn round a centre like a hanging ſtair. It has been minutely, but not ſimply, deſcribed; and, indeed, there can be nothing more difficult, than to deſcribe it in words.

When the os petroſum is cut from around the cochlea, it is ſeen to be of a pyramidal ſhape, and to conſiſt of a ſcroll, making large circles at the baſe, and gradually leſſer ones towards the apex. It is formed in the moſt anterior part of the petrous bone, and has its apex turned a little downward and outward; and the baſe is oppoſed to the great cul de ſac of the internal meatus auditorius.

The ſpiral tube, of which the cochlea is compoſed, forms two turns and a half from the baſis to the point; and it conſiſts of the ſame hard and brittle matter with the ſemicircular canals. When the whole cochlea is cut perpendicularly in the dry ſtate of the bones, and when the membranes have ſhrunk away or ſpoiled, the ſides of the ſpiral canal appear like partitions, and are, indeed, generally deſcribed as ſuch. In conſequence of the ſpiral tube of the cochlea having its ſides cut perpendicularly, the cochlea appears as if divided into three circular compartments or ſucceſſive ſtages; but there is really no ſuch diviſion; becauſe the ſpiral turnings of the tube lead from the one into the other.

Fig. 19.

Cochlea



A. *Scalæ*. B. *Lamina Spiralis*

C.C. *Modiolus*. D. *Infundibulum*.

What gives particular intricacy to the ſtructure of this part of the labyrinth, is the LAMINA SPIRALIS.

 This

This ſpiral partition runs in the ſpiral tube of the cochlea, ſo as to divide it in its whole length; and, in the freſh ſtate of the parts, this lamina of bone is eked out by membrane, ſo as to form two perfectly diſtinct tubes. Theſe tubes are the SCALÆ COCHLEÆ; they run into each other at the apex of the cochlea; but at the baſe, the one turns into the veſtibule, and the other opens into the tympanum by the FORAMEN ROTUNDUM.

In the middle of the cochlea there runs down a pillar, which is the centre of the circumvolutions of the ſcalæ. It is called the MODIOLUS. This pillar is of a ſpongy ſtructure; and through it the nerves are tranſmitted to the lamina ſpiralis, and ſides of the cochlea.

The modiolus opens towards the apex of the cochlea like a funnel; and when we take away the outward ſhell of the apex of the cochlea, which is called the CUPOLA, we look into this expanſion of the upper part of the modiolus as into a funnel; it is therefore called the INFUNDIBULUM. The infundibulum is that part which, in a perpendicular ſection, we ſhould call the upper partition *.

The ſcalæ or diviſions of the ſpiral tube of the cochlea, have a communication at their ſmaller extremities in the infundibulum; and as, again, their larger extremities do not open into the ſame cavity, but one into the veſtibule, and the other into the tympanum, the vibrating motion, which is communicated through the cochlea, muſt paſs either from the tympanum into

* That is ſuppoſing the cochlea to reſt on its baſe.

the

the foramen rotundum, circulate round the modiolus by the ſcala tympani, paſs into the leſſer extremity of the ſcala veſtibuli in the infundibulum, and circulate through it towards the baſe of the cochlea, until it paſs into the veſtibule; or it muſt paſs from the ſcala veſtibuli into the ſcala tympani. The firſt is the opinion of Scarpa and others. But I truſt it will afterwards appear, that the oſcillations of ſound are in the firſt place conveyed into the veſtibule, and thence circulate round both the ſemicircular canals and cochlea.

In the dry bones, when we cut into the cochlea, there appears a ſpiral tube, as I have deſcribed; with a partition running along it, and, of courſe, taking the ſame ſpiral turns with it towards the apex. This is the boney part of the lamina ſpiralis; but, as the membrane which extends from its circular edge quite acroſs the ſpiral tube of the cochlea, has ſhrunk and fallen away in the dry ſtate of the parts, the lamina ſpiralis is like a hanging ſtair, and the ſcalæ are not divided into diſtinct paſſages. In this bare ſtate of the ſhell of the cochlea, when we cut away the cupola or apex of the cochlea, and look down upon the infundibulum, we ſee the extreme point of the lamina ſpiralis riſing in an acute hook-like point.

The modiolus or central pillar, and the lamina ſpiralis which encircles it, are of the moſt exquiſite and delicate ſtructure; for, through them the portion of the ſeventh nerve deſtined to the cochlea is conveyed. To ſay that the modiolus is formed of two central bones, is ſaying that there is no central column at all; or, that the modiolus is the cavity ſeen in the bottom of the meatus auditorius: and to affirm, at the ſame

ſame time, that the modiolus is a nucleus, axis, or central pillar, is a contradiction in terms.

When we break away the ſhell of the cochlea, and break off, alſo, the ſpiral lamina, we find the little funnel-like depreſſion in the bottom of the meatus internus reaching but a little way up into the centre of the cochlea.—We find this depreſſion of the meatus auditorius internus perforated with innumerable ſmall holes; and theſe foramina are ſo placed as to trace a ſpiral line, becauſe they give paſſage to the nerves going to the ſpiral lamina, and muſt take the form of the diminiſhing gyrations of the lamina ſpiralis. In the centre of theſe leſſer foramina, which are ſeen in the bottom of the great foramen auditorium internum, there is a hole of comparatively a large ſize, which paſſes up through the middle of the pillar. The modiolus is formed of a looſe ſpongy texture, and reſembles the turns of a cork-ſcrew; and this ſpiral direction is a neceſſary conſequence of the lamina ſpiralis, being a continuation of the ſpongy or cribriform texture of the modiolus.

INTERNAL PERIOSTEUM OF THE LABYRINTH. We find that the veſtibule, the ſemicircular canals, and cochlea, beſides their ſoft contents, which we have yet to deſcribe, have their proper perioſteum, which, after a minute injection, appears vaſcular; and this, as it has appeared to me, is particularly the caſe with the laſt mentioned diviſion of the labyrinth. I ſee very conſiderable veſſels diſtributed on the veſtibule; particularly, I ſee their minute ramifications on the circular fovea, while very conſiderable branches are ſeen to courſe along the ſemicircular canals. In the cochlea, I ſee

I ſee diſtinct branches of veſſels riſing from the root of the lamina ſpiralis, and arching on the ſcalæ, to the number of ten in the circle; and, after a more minute injection, I have found the oſſeous part of the lamina ſpiralis tinged red, and the membranous part of a deep ſcarlet *.

We have obſerved the MEATUS AUDITORIUS INTERNUS to be a large oval foramen in the poſterior ſurface of the pars petroſa of the temporal bone. This tube tranſmits the ſeventh or auditory nerve. It is about five lines in diameter, but encreaſes as it paſſes inward; and appears to terminate in two deep fovea, which are divided by an acute ſpine. But the auditory foramen only appears to terminate in theſe fovea, for they are each perforated by leſſer holes, which lead into the three diviſions of the labyrinth, whilſt a larger one conveys a portion of the nerve through the cavities of the temporal bone altogether, and out upon the ſide of the face. This larger foramen is in the upper part of the ſuperior and leſſer fovea. It firſt aſcends to near the ſurface of the petrous part of the temporal bone †, and then deſcends and turns backward and takes a courſe round the tympanum above the foramen ovale; and cloſe by the poſterior ſemicircular canal. Its termination is the foramen ſtylo maſtoideum ‡.

* In a preparation before me, I ſee a conſiderable artery derived from the baſilar artery, and entering the meatus auditorius internus. From this trunk, I conceive that moſt of theſe arteries which I have deſcribed, are derived.

† In the fœtus, it becomes here ſuperficial.

‡ This the aqueduct of Fallopius.

Where

Where this canal of the portio dura advances towards the ſurface of the pars petroſa, it is joined by a very ſmall canal which extends from the videan hole on the fore part of the inclining face of the bone: again, after it has paſſed the tympanum, it is joined by a ſhort canal which receives the corda tympani, after it has paſſed the tympanum.

The other foramen which is in the upper and leſſer fovea of the meatus internus, is rather a cribriform plate, as it is a deep pit with many foramina in it. Theſe lead into the veſtibule, and form the MACULA CRIBROSA VESTIBULI *. In the inferior and larger fovea, we obſerve ſeveral dark ſpots, which, when more narrowly examined, are alſo diſtinguiſhed to be cribriform plates, or collections of leſſer foramina. We particularly obſerve that conical cavity which is perforated with many little pores for tranſmitting the nerve into the cochlea, and which we have already mentioned. From the form which theſe foramina take, this is named the TRACTUS SPIRALIS FORAMINOLOSUS. Theſe foramina, after paſſing along the modiolus cochleæ, turn at right angles, and paſs betwixt the plates of the lamina ſpiralis.

Beſides the tractus ſpiralis foraminoloſus, the bottom of the larger fovea has many irregular foramina, which are like cancelli: for very delicate ſpeculæ of bone ſtand acroſs ſome of them. There is a range of theſe foramina which ſtretches from the tractus ſpiralis. This may properly be called the TRACTUS CALTHRA-

* See Scarpa, Plate VII., fig. i, m.

TUS

TUS RECTUS *; they do not lead into the veſtibule, but into the beginning of the lamina ſpiralis, where it divides the two ſcalæ cochleæ, and turns the orifice of one of them, (by a beautiful curve), out into the tympanum.

Nearer to the ridge which divides the two foveæ of the meatus internus, there is a little pit which has alſo a cribriform plate (like that which is in the upper fovea, and is called macula cribroſa); oppoſite to this point, the inſide of the veſtibule is rough and ſpongy: it tranſmits a portion of the nerve to the ſacculus in the hemiſpherical ſinus of the veſtibule †.

OF THE SOFT PARTS CONTAINED IN THE LABYRINTH.

Within the veſtibule, ſemicircular canals, and cochlea, there are ſoft membranes independent of the perioſteum. Theſe form ſacculi and tubes which contain a fluid, and have the extreme branches of the portio mollis diſtributed among them. Betwixt the ſoft and organized ſacculi and tubes, and the perioſteum of the oſſeous labyrinth, a watery fluid is exuded.

SACCULUS VESTIBULI. The hemiſpherical and ſemi-eliptical foveæ which we have deſcribed in the veſtibule, contain, or at leaſt receive partially, two ſacculi. The ſacculus which is in the hemiſpherical cavity, receives the moſt convex part of the ſacculus veſtibuli. This ſac is diſtended with a fluid, and is pellucid, and

* Tractus ſpiralis foraminuloſi initium. Scarpa.

† Scarpa.

fills

fills the greater part of the veſtibule; for only a part of it is received into the fovea. It forms a complete ſac, and has no communication with the other ſoft parts of the labyrinth, though lying in contact with the alveus communis, preſently to be mentioned; and being ſurrounded with an aqueous fluid, it muſt receive the impreſſions of ſound in common with them.

ALVEUS COMMUNIS DUCTUUM SEMICIRCULARUM. This ſacculus lies in the ſemi-eliptical fovea of the veſtibule, or, like the other ſacculus, is in part received into it. This ſacculus receives the extremities of the tubuli membranacei which lie in the ſemicircular canals; it is a little bag common to them, and connecting them altogether, as in fiſhes: it is filled with fluid, and is ſo pellucid, as to be diſtinguiſhed with much difficulty *. Upon preſſing the common ſac, or the ampululæ of the ſemicircular canals, the fluids are ſeen to circulate along the membranous tubes of the canals. Theſe two ſacculi in the veſtibule lie together, and firmly adhere, but do not communicate; yet, (as may be eaſily imagined), they cannot be ſeparated without tearing the partition.

TUBULI MEMBRANACII. The tubuli membranacii are the ſemicircular tubes which paſs along the oſſeous ſemicircular canals, and to which the latter are ſubſervient, merely as ſupporting them. They are connected by means of the common alveus in the veſtibule, and form a diſtinct diviſion of the organ.

* Proprio humore turgidus adeo tranſlucet ut ablongum bullulam aèream mentiatur. Scarpa, p. 47.

It

It was believed by anatomiſts formerly, that the oſſeous canals had the pulp of the nerve expanded on their perioſteum. But we find, on the contrary, that the membranous tubuli do not touch the bones, but are connected with them by a tranſparent cellular membrane-like mucus. Each of the ſemicircular membranous tubes has one extremity ſwelled out into an ampulla of an oval form, anſwering to the dilated extremity of thoſe oſſeous tubes which we have already deſcribed. Theſe ampullæ have the ſame ſtructure and uſe with thoſe formerly mentioned in deſcribing the ear in fiſhes. When the central belly of theſe tubes is punctured, both the ampullæ and the membranous canals fall flaccid.

Beſides thoſe veſſels which we have deſcribed running along the perioſteum of the cavities of the labyrinth, veſſels alſo play upon the ſacculi and membranous tubes. The ampullæ of the tubes are, in a particular manner, ſupplied with blood-veſſels *.

In the COCHLEA there is alſo a pulpy membrane, independent of the perioſteum; but of this I can ſay nothing from my own diſſection.

* "Caeterum univerſum hoc canaliculorum membraneorum "alveique communis machinamentum, ſanguiferis vaſis inſtruitur, "quorum craſſiora, circum alveum communem, ſerpentino inceſſu, "ludunt; crebra et conferta alia *ampullæ* imprimis recipiunt ob "quam cauſam rubellæ plerumque ſunt et cruore veluti ſuffuſæ." Scarpa, p. 47.

SECT.

SECTION IV.

OF THE NERVE.

As the ſeventh pair of nerves ariſes in ſeveral faſciculi, they form what would be a flat nerve, were it not twiſted into a cylindrical form, adapted to the foramen auditorium internum. While theſe faſciculi are wrapped in one common coat, they are matted together. In the canal, the nerve is divided nearly into two equal parts*; to the cochlea and to the veſtibulum and ſemicircular canals. Thoſe faſciculi, which are deſtined for the veſtibule, are the moſt conſpicuous; and on the portion deſtined for the ampullæ of the ſuperior and external canal, there is formed a kind of knot or ganglion.

Before the auditory nerves paſs through the minute foramina in the bottom of the meatus auditorius, they lay aſide their coats and become more tender and of a purer white colour; and, by being ſtill further ſubdivided by the minute branching and diviſions of the foramina, they cannot be followed, but finally expand in a white pulpy-like ſubſtance on the ſacs and ampullæ. We muſt, however, recollect that there was a difference to be obſerved in the apparent texture of theſe expanded nerves in the lower animals: we may obſerve here, alſo, that part of the nerve which is expanded on the common belly or ſacculus tubulorum,

* Of the portio dura we have already ſpoken.

is ſpread like a fan upon the outer ſurface of the ſac, and has a beautiful fibrous texture; but upon the inſide of the ſac, upon which it is finally diſtributed, it loſes the fibrous appearance. We muſt ſuppoſe its final diſtribution to be in filaments ſo extremely minute, that we may call it a pulp; though by the term it muſt not be underſtood that an unorganized matter is meant.

That part of the nerve which ſtretches to the ampullæ, immediately divides into an opaque white mucous-like expanſion. Beyond theſe ampullæ, there has been no expanſion of the nerve diſcovered in the membranous tubes.

The ſacculus veſtibuli * is ſupplied by a portion of the nerve which perforates the macula foraminuloſa in the centre of the oſſeous excavation, or that which receives into it part of the ſac. This part of the nerve is expanded in a ſoft mucous-like white matter in the bottom and ſides of the ſac.

A diviſion of the nerve, as we have already explained, paſſes from the meatus auditorius internus through the cribriform baſe of the modiolus into the cochlea. Owing to the circular or ſpiral form of the foramina when the nerve is drawn out from the meatus, its extremity appears as if it had taken the impreſſion of theſe foramina from the extremities of the torn nerves preſerving the ſame circular form. Theſe nerves, paſſing along the modiolus and ſcalæ cochleæ, are in their courſe ſubdivided to great mi-

* i. e. In oppoſition to the ſacculus tubulorum.

nuteneſs.

nutenefs. Part of them perforate the fides of the modiolus, whilft others pafs along betwixt the two plates of the lamina fpiralis, and out by the minute holes in the plates and from betwixt their edges. Laftly, a central filament paffes up through the centre of the modiolus, and rifes through a cribriform part into the infundibulum to fupply the infundibulum and cupola.

Where the nerves pafs along the lamina fpiralis, their delicate fibres are matted together into a network. According to the obfervations of Dr. Monro, they are quite tranfparent on their extremities.

CHAP. V.

OF HEARING IN GENERAL.

When aerial undulations were, by the experiments on the air pump, firſt proved to be the cauſe of ſounds, philoſophers looked no further to the ſtructure of the ear than to diſcover an apparatus adapted to the reception of ſuch vibrations. When they obſerved the ſtructure of the membrane of the tympanum, and its admirable capacity for receiving theſe motions of the atmoſphere, they were ſatisfied, without conſidering the immediate objects of ſenſation. In the ſame way, an ignorant perſon, at this day, would reſt ſatisfied with the fact that ſound was received upon the drum of the ear. But after ſo minutely explaining the anatomy of the ear, it becomes us to take a general ſurvey of a ſtructure the moſt beautiful which the mind can contemplate. We cannot ſay that it ſurpaſſes in beauty the ſtructure of other parts of the body: but the parts are adapted to each other, in a manner ſo ſimple, efficient, and perfect, that we can better underſtand and appreciate the harmony of their ſtructure than that of organs, which perform their functions by qualities and actions almoſt entirely unintelligible to us.

We

We ſee that the external ear collects the vibrations of ſound as it moves in the atmoſphere with circular undulation from the ſonorous body: here we may obſerve, that where the neceſſities of animals require them to be better provided with this external part of the organ than man, the ſuperiority is only in the ſimple perception of ſound; while man, from the perfection of the internal organ, excels all animals in the capacity of the ear for articulate and muſical ſounds.

From the external ear we obſerve, that the trumpet-like tube conveys the ſound inward to the membrane of the tympanum. Behind the membrane of the tympanum, there is a cavity which, in order to allow of the free vibration of the membrane, contains air.—When this air is pent up, by the ſwelling or adheſion of the euſtachean tube, the elaſticity of the air is diminiſhed, and the membrane prevented from vibrating *.

In the tympanum, we have ſeen that the operation of the chain of bones is to encreaſe the vibration received upon the membrane of the tympanum, and to tranſmit it to the membrane of the foramen ovale. In the cavity of the tympanum we obſerved two foramina, the foramen ovale and the foramen rotundum, both of which lead into the labyrinth; but one of them (the foramen ovale) into the veſtibule, the other (the foramen rotundum) into the ſcala of the cochlea; now it be-

* See *Recherches*, &c. *relatives a l'organe de l'ouie & a la propagation des ſous*, par M. Perolle, Societ. R. de Medecine, tom. iii.

comes a queſtion, whether the oſcillations of ſound paſs by one or by both of theſe foramina?

It is the opinion of many, that while the chain of bones receives the motion of the membrane of the tympanum, the motion of this membrane at the ſame time cauſes a vibration of the air in the tympanum which reaches the foramen rotundum, and thus conveys a double motion through the cochlea.

In the labyrinth there is no air, but only an aqueous fluid: now this, we have ſeen, conveys a ſtronger impulſe than the atmoſphere; ſtronger in proportion to its greater ſpecific gravity and want of elaſticity; for an elaſtic fluid like air may be compreſſed by concuſſion, but an inelaſtic fluid muſt tranſmit fairly every degree of motion it receives. But if the fluid of the labyrinth be ſurrounded on all ſides; if, as is really the caſe, there can be no free ſpace in the labyrinth, it can partake of no motion, and is ill ſuited to receive the oſcillations of ſound. Againſt this perfect inertia of the fluids of the labyrinth I conceive the FORAMEN ROTUNDUM to be a proviſion. It has a membrane ſpread over it, ſimilar to that which cloſes the foramen ovale. As the foramen ovale receives the vibrations from the bones of the tympanum, they circulate through the intricate windings of the labyrinth, and are again tranſmitted to the air in the tympanum by the foramen rotundum. Without ſuch an opening there could be no circulation of the vibration in the labyrinth; no motion of the fluids communicated through the contiguous ſacculi, nor through the ſcalæ of the cochlea; becauſe there would be an

abſolute

abſolute and uniform reſiſtance to the motion of the fluids.—But, as it is, the proviſion is beautiful. The membrane of the foramen rotundum alone gives way of all the ſurfaces within the labyrinth, and this leads the courſe of the undulations of the fluid in the labyrinth in a certain unchangeable direction.

To me it appears, that to give a double direction to the motion of the fluids, or to the vibration in the labyrinth, far from encreaſing the effect, would tend to annihilate the vibrations of both foramina by antagonizing them. The common idea is, that there is a motion communicated through the membrane of the foramen rotundum along the ſcala tympani, and another through the foramen ovale into the veſtibule, and through the veſtibule into the ſcala veſtibuli; and that the concuſſion of theſe meet in the infundibulum of the cochlea. But as there is no ſpace for motion in the fluids in either the one or other of theſe tracts, the vibration muſt have been received in the infundibulum at the ſame time that the motion was communicated to the membranes of the foramen ovale and rotundum; for if a tube full of water, a mile in length, loſes one drop from the extremity, there muſt be an inſtantaneous motion through the whole to ſupply its place. The evident conſequence of this double motion would be, (if they were of the ſame ſtrength) to ſuppreſs all motion or vibration in the fluids of the labyrinth.

But we have ſhown that the ſtrength of vibration communicated to the foramen ovale and foramen rotundum are not the ſame: for the mechaniſm of the

bones in the tympanum is ſuch as to accumulate a greater force or extent of motion on the membrana ovalis, than is received upon the membrana tympani; therefore the greater vibration which is communicated through the medium of the air in the tympanum, cannot be ſuppoſed capable of oppoſing the ſtronger vibration which circulates from the foramen ovale through the labyrinth, and returns by the foramen rotundum. Beſides, the air in the tympanum has a free egreſs, and cannot therefore ſtrike the membrane on the foramen rotundum forcibly.

For theſe ſeveral reaſons, I conceive that the following account of the manner in which the ſound is conveyed is erroneous:—" Et quo ad zonam cochleæ " ſpiralem quoniam altera cochleæ ſcala in veſtibulo " patet, altera a FENESTRA ROTUNDA initium ſumit, " atque earum utraque aqua labyrinthi repleta eſt, et " ſcalæ in apice cochleæ ſimul communicant, zona " ſpiralis inter duas veluti undas ſonoras media, a " tremoribus per vaſim ſtapedis, ſimulque ab iis per " membranam *feneſtræ rotundæ* advectis utraque in " facie percellitur et una cum percillis acauſtici nervi " per eam diſtributis contremiſcit: quibus porro omnibus, in ampullis videlicet canaliculorum ſemicir" cularium, alveo eorum communi, ſacculo veſtibuli " ſpherico et lamina cochleæ ſpirali acauſtici nervi " affectionibus auditum contineri nemo non in" telligit *."

As to the immediate ſeat of the ſenſe of hearing, there cannot, after what has been explained regarding the di-

* Scarpa, p. 61.

ſtribution

ſtribution of the nerves, remain any controverſy; though before the ſtructure of the ear was ſo well underſtood, ſome imagined that the veſtibule, others that the middle part of the ſemicircular canals, was the ſeat of hearing; others, again, that the lamina ſpiralis was better adapted for receiving the vibrations of ſound. It is evident that the ſoft expanſion of the nerve, in all the three diviſions of the labyrinth, is deſtined to receive the undulation of the contained fluids, and that this motion of the fluids gives to the nerve, or to the nerve and brain conjointly, the ſenſation of hearing.

Since we have, in ſome meaſure, traced the ſtructure of the ear from the animals of a ſimple ſtructure to thoſe of a more complicated organization, and have obſerved ſome parts of the ear common to all animals, ſome peculiar to certain orders; and ſince all have the ſenſe of hearing, more or leſs accute, it becomes natural to enquire what are the parts of the organ the moſt eſſential to the mere perception of ſound, and what parts conduce to a more perfect ſtate of the ſenſe.

All the external apparatus of the ear is not neceſſary to give the animal the ſimple perception of ſound.—There are many claſſes of animals altogether without them, and even in man we ſee that they are not abſolutely neceſſary; ſince when deprived of them by diſeaſe, man ſtill enjoys the ſenſe. He is deprived of no eſſential variety of the ſenſation; he is capable of perceiving the diſtinctions of articulate ſound; and ſtill poſſeſſes his muſical ear. The external apparatus of the ear, the membrane of the tympanum, the little bones, and even the external ear, only receive, con-

centrate,

centrate, and encreafe the tremors of the external air, and render the flighter impreffions audible.

It would appear, that the fimple fac of the veftibule is fufficient to receive the impreffion in fome animals, and that in many the veftibule and femicircular canals form folely the organ of hearing. It is evident, therefore, that thefe are the moft effential parts. We fee alfo an intention in the ftrict fimilarity of figure and place in thefe canals through all the varieties of animals, from fifhes to man. It would feem to indicate, that there is in their form and pofition a peculiar provifion for the ofcillation of found producing the full effect.

We find, however, that the cochlea is imperfect in birds; and that it is fully formed only in man, and in quadrupeds: we muft, therefore, conclude, that it is fubfervient to the more exquifite fenfations. I do not conceive that the cochlea or any part of the organ particularly conduces to the beftowing of a mufical ear, although it is by hearing that we are capable of the perceptions of melody and harmony, and of all the charms of mufic; yet it would feem, that this depends upon the mind, and is not an operation confined to the organ. It is enjoyed in a very different degree by thofe whofe fimple faculty of hearing is equally perfect *.

Even after ftudying, with all diligence, the anatomical ftructure of the ear, we cannot but be aftonifhed with the varieties to be found in the fenfation; for ex-

* See Reid's Enquiry.

ample:

ample:—"The ear is capable of perceiving four or "five hundred variations of tone in ſound, and pro- "bably as many different degrees of ſtrength; by com- "bining theſe, we have above twenty thouſand ſimple "ſounds that differ either in tone or ſtrength, ſup- "poſing every tone to be perfect. But it is to be ob- "ſerved, that to make a perfect tone, a great many "undulations of elaſtic air are required, which muſt "all be of equal duration and extent, and follow one "another with perfect regularity; and each undula- "tion muſt be made up of the advance and recoil of "innumerable particles of elaſtic air, whoſe motions "are all uniform in direction, force, and time. Hence "we may eaſily conceive a prodigious variety in the "ſame tone, ariſing from irregularities of it occaſioned "by conſtitution, figure, ſituation, or manner of ſtrik- "ing the ſonorous body; from the conſtitution of the "elaſtic medium, or its being diſturbed by other "motions; and from the conſtitution of the ear itſelf "upon which the impreſſion is made. A flute, a "violin, a hautboy, a French horn, may all ſound the "ſame tone, and be eaſily diſtinguiſhable. Nay, if "twenty human voices ſound the ſame note, and with "equal ſtrength, there will ſtill be ſome difference. "The ſame voice, while it retains its proper diſtinc- "tions, may yet be varied many ways: by ſickneſs "or health, youth or age, leanneſs or fatneſs, good or "bad humour. The ſame words, ſpoken by foreigners "and natives, nay by different provinces of the ſame "nation, may be diſtinguiſhed *."

* Reid's Enquiry, p. 98.

That

That this variety of ſenſation does not entirely depend upon the ſtructure, but is the operation of the ſenſe and intellect conjointly, appears from the long experience which is requiſite to give this perfection. Nature is bountiful in providing the means of ſimple and acquired perception, but the latter is the reſult of long experience and continued effort, though we have loſt the feeling of its being originally a voluntary effort.

CHAP. VI.

OF THE DISEASES OF THE INTERNAL EAR.

Of all the causes of deafness, that which proceeds from an organic disease of the brain is, of course, the most dangerous. In apoplectic affections, with faul tering of speech and blindness, deafness is also produced by the general affection of the brain. But worst of all is the case where a tumor of the brain, or betwixt the cerebrum and cerebellum, compresses the origin of the nerves *. I have, however, observed, that a tumor in the *vicinity* of the origin of the auditory nerve, though it ran its course so as to prove fatal, had rather a contrary effect on the organ of hearing; and while the pupil of the eye remained stationary, and the man saw indistinctly, he had a morbid acuteness of hearing. This had probably been produced by the surrounding inflammation having extended to the origins of the au-

* Vidit Clariss. Dom. Drelincurtius Tumorem steatomatis consistentia pugnique magnitudine, cerebrum et cerebellum inter, eo præcisè loco ubi conarium utrique substeritur choroidis plexus alæ, spatio semestri a sensibili læsione, cæcitatem primo, surditatem subinde, omnium denique sensuum et functionum animalium abolitionem et necem ipsam intulisse." Bonet. vol. i. p. 123. ob. 53. In Sandifort Obs. Anatom. Path. tom. i. p. 116. there is an instance in which the auditory nerve had a cartilaginous tumor adhering to it.

ditory

ditory nerves. The auditory nerve often becomes morbidly ſenſible, and the patient ſuffers by the acuteneſs of perception, or is diſtreſſed with the tinnitus aurium, which is, in this caſe, analogous to the flaſhes of light which ſometimes affect the eye in total darkneſs, and which thoſe experience who are totally blind or have cataract. So morbidly acute does the ſenſation ſometimes become, that the ſlighteſt motion of the head will excite a ſenſation like the ringing of a great bell cloſe to the ear *. With delirium, vertigo, epilepſy, hyſteria, the encreaſed ſenſibility of the organ becomes a ſource of painful ſenſation.

In apoplectic affections, with faultering of ſpeech and blindneſs, there is alſo deafneſs; becauſe the affection of the brain is general. With a paralytic ſtate of the muſcles of the face, there is deafneſs of the correſponding ear, if the affection of the nerve be near the brain; which is explained by the ſtrict connection betwixt the auditory nerve and the nervus communicans faciei. From obſerving the courſe of the nervus communicans faciei through the temporal bone, and its connections in the tympanum, we underſtand why, in violent tooth-ach and in the tic douloureuſe, we find the euſtachean tube and root of the tongue affected. The ear is ſometimes affected by ſympathy of parts: for example—from foulneſs of the ſtomach and bowels; and the ſame reaſon may be

* F. Hoffman. Conſult. et Reſponſ. Caſ. xxxix. We muſt not, however, take his reaſoning after what we have ſeen of the ſtructure of the ear, that the viſcid petuita, ſeparated in the concha, cochlea, and labyrinth, reſolved into halitus endeavouring to eſcape, produces the ſuſurrus et tinnitus aurium.

aſſigned

aſſigned for the complaint of hypochondriacs, that they are moleſted with ſtrange ſounds. And in the caſe of inteſtinal worms, we find the patient complaining of murmuring and ringing in the ears *. Of the organic diſeaſes of the labyrinth, there is little on record. It would appear, that the fluids become often ſo altered in their conſiſtance as to prove an abſolute deſtruction to the organ. Mr. Cline found in a perſon deaf from birth, that the whole labyrinth was filled with a ſubſtance like cheeſe.

A diſeaſe of the auditory nerve, like that of the retina in the gutta ſerena, is no unfrequent complaint †.

We ought, at all events, before propoſing any operation on the ear, to obſerve whether the diſeaſe be not in the ſeat of the ſenſe, and ſuch as will not yield to any practice; otherwiſe, as in the more important operations when done in circumſtances which preclude the poſſibility of ſucceſs, the public is impreſſed with its inefficacy and danger, and we are precluded from giving relief on occaſions more favourable for our operations.

Deafneſs, in acute fever, is a good ſign; becauſe, ſay authors, it argues a metaſtaſis of the morbific matter. We ſhould rather ſay, becauſe it argues a dimi-

* Hoffmann. Med. Conſult. Boerhaave. The ſympathy is ſometimes exerted in another way:—" Ex muſices tonitru aut ſola " meatus auditorii externi contrectatione, vomitus urinae incon" tinentia." Sauv.

† Dyſecoea (atonica) ſine organorum ſonos tranſmittentium vitio evidente. Cullen. Cophoſis *Sauv.* *Cophoſis* a *Paracuſi* diſtinguitur ut *amauroſis* ab *omblyopia* reſpectiva. Sauv.

 nution

nution of the morbid ſenſibility of the brain*. But the ſurcharge of the veſſels of the brain or of the auditory nerve will alſo produce deafneſs and unuſual ſenſations in the ear: as in ſuppreſſion of the menſes and hæmorrhoids, in ſurfeit, &c. in which caſes it is often preceded by vertigo and head-ach.

There occurs a very curious inſtance of analogy betwixt the ears and eyes in the following caſes:—"A certain eminent muſician, when he blew the German flute, perceived at the ſame time the proper ſound of it and another ſound of the ſame rythm or meaſure, but of a different tone. His hearing ſeemed thus to be doubled. It was not an echo; for he heard both ſounds at one and the ſame moment: neither were the ſounds accordant and harmonious, for that would have been ſweet and pleaſant to his ear. Having for ſeveral days perſiſted in his attempts, and always been ſhocked with this grating ſound, he at laſt threw his flute aſide. The day before the firſt became ſenſible of this ſtrange affection, he had imprudently walked in a very cold and damp evening, and was ſeized with a catarrh in the right ſide. Whence, probably, it aroſe that the natural tone of that ear was altered: the ſound appeared more grave, and diſſonant from that received by the left ear. Having recovered from the catarrh, the diſtinct hearing of his ear was reſtored."

* But the difficulty of knowing when the deafneſs is the reſult of diſeaſe, or malconformation in the parts tranſmitting the ſound to the nerve, and when in the brain and nerve, has led to more uncertainty and confuſion with regard to the ſpecies and varieties of the diſorders of the ear than in the eye; where the tranſparency of the humors aſſiſt in the definition.

Sauvage, who relates this caſe, ſubjoins another :—
"Very lately," ſays he, "a foreigner came for advice in a ſimilar ſituation. He complained that when any perſon ſpoke to him, he heard the proper ſound of the voice, and at the ſame time another ſound accompanying it an octave higher, and almoſt intolerable to him. As it muſt have happened that if the accompanying ſound had preſerved the true octave above the voice, and been ſynchronous with it, the ear would have received them as one ſound, and been pleaſed with their concord : it is probable that the accompanying ſound was not in uniſon with the true. Sauvage, vol. iii. p. 352.

BOOK III.

OF THE NOSE AND THE ORGAN OF SMELLING.

OF THE SENSE OF SMELLING.

SMELLING ſeems to be the leaſt perfect of the ſenſes. It conveys to us the ſimpleſt idea, and is the leaſt ſubſervient to the others. The ſenſations it preſents to us we can leſs eaſily recall to memory; and the aſſociations connected with it are leſs preciſe and definite than thoſe of the ſenſes of hearing and ſeeing.

Animal and vegetable bodies, during their life, growth, putrifaction, and fermentation, and, moſt probably, all bodies whatever, are perpetually giving out effluvia of great ſubtlety. Thoſe volatile particles repelling each other, or being diffuſed in the atmoſphere, are inhaled by the noſe, and convey to the pituitary membrane of the noſe the ſenſation of ſmell.

Immediately within the noſtrils, there are two cavities ſeparated by the boney partition, which has been already deſcribed in treating of the bones. Theſe

cavities enlarge as they proceed inward, and open backward into the throat, and, consequently, communicate with the mouth. They extend upward and sideways into the cells of the bones of the face; and the petuitary membrane is much extended over the surfaces of these winding passages, and over the irregular surfaces of the nose, formed by the projecting cartilages of the œthmoid and lower spongy bones; which, also, have already been sufficiently described.

The cavities of the nose lead into many cells in the bones of the face, which, if not subservient to the organ, assist in giving vibration and tone to the voice. The cavities of the nose are continued upwards into the frontal sinuses, and into the cells of the œthmoid bone; backward and upward into the sphenoid sinus; and upon the sides into the antra higmoriana or sinuses of the upper maxillary bones.

The membrane covering the surface of these bones is called the MEMBRANA SCHNEIDERIANA, the mucous or pituitary membrane. It is of a glandular structure, or is lubricated by the mucus discharged by the folicules on its surface. This secretion on the surface of the membrane, is to defend its delicate and sensible structure from the effects of the air, while it preserves the sensibility of the surface and the delicate expanded nerve. It seems of a nature to allow the effluvia to penetrate it.

It appears to me, that a very particular provision has been made against the too powerful effect of smells while the membrane is inflamed, and, consequently, in a state of great sensibility. When the membrane is

 inflamed,

inflamed, the ſecretion is ſo altered, that the effluvia do not penetrate ſo as to effect the nerve in its ſtate of extreme ſenſibility.

We have already deſcribed the courſe of the firſt pair of nerves or the olfactory nerves, and alſo thoſe branches of the common nerves which are diſtributed to the membrane of the noſe. Theſe, it were ſuperfluous to recapitulate here. It was ſuggeſted as the moſt probable opinion, that the olfactory nerve alone is ſubſervient to theſe parts conſidered as the organ of ſmelling, and that the adventitious branches ſupply merely the common ſenſibility which the nerves beſtow promiſcuouſly over the body. This ſenſible and nervous membrane, and this glandular and ſecreting membrane, is extremely vaſcular, as it is natural a priori to ſuppoſe; and this vaſcularity, this glandular ſtructure, and its expoſed ſtate, makes it liable to frequent diſeaſe: and, when diſeaſed, when tumors and polypi form in it, we muſt never forget the extreme thinneſs and delicacy of the ſurrounding bones, which, when they are either preſſed upon by tumors, or have their membranes eroded, are ſoon totally deſtroyed. It is with manifeſt deſign, that the organ which ſo particularly admoniſhes us of the effluvia diffuſed in the air we breath, ſhould have been placed in the entrance to the canal of the lungs. It is, in ſome meaſure, a guard to the lungs, as the ſenſibility of the tongue guards the alimentary canal. That the humidity of the membrane either preſerves the ſenſibility of the noſe, or is a ſolvent, in which the effiuvia diſſolving affect the nerves, is evident; for the

the ſenſe is loſt when the membrane becomes dried. The ſenſibility is alſo affected in various ways by too abundant a mucous diſcharge, or by an alteration of its natural properties; by the infarction and thickening of the membrane, as in ozæna; by obſtructions preventing the current of air through the noſe, as in polypi, &c.

BOOK IV.

OF THE MOUTH, SALIVARY GLANDS, AND ORGAN OF TASTE.

CHAP. I.

OF THE MOUTH AND TONGUE.

ALTHOUGH it is not neceſſary to ſay, that the mouth is " betwixt the noſe and chin," that " there are lips " ſerviceable to the purpoſes of ſpeaking, eating, and " drinking;" though it be not neceſſary to lay it down circumſtantially, that there are cheeks on the face, and a tongue in the mouth; yet is there much important anatomy, and very uſeful knowledge neceſſary to be acquired here.

Of the TONGUE, it is only neceſſary to obſerve its form, and the terms uſed in its deſcription. The BODY of the tongue conſiſts of the muſcular fibres, with intermingled fat and cellular membrane; and the muſcles which chiefly compoſe it, are the linguales, ſtylogloſſi, and geniogloſſi muſcles.

The

The BASE of the tongue is connected with the os hyoides.

The ſurface applied to the roof of the mouth is the DORSUM; and on this ſurface there is to be obſerved a middle line, dividing the tongue into two lateral portions; a diviſion which is very accurately preſerved in the diſtribution of the blood-veſſels and nerves of either ſide. On the dorſum, towards the baſe, the ſurface is rough with the papillæ maximæ and foramen cæcum of Morgagni. Theſe papillæ are like ſmall glands ſeated in little ſuperficial foſſulæ, ſo that their broad muſh-room-like heads alone are ſeen; but they are connected with the bottom of the foſſulæ by ſhort ſtems or necks. This is altogether a glandular apparatus. The foramen cæcum is, in truth, only an enlarged apparatus of the ſame kind, for, in the bottom of this foramen, many glandular papillæ ſtand up; and in its bottom ſmall foramina have been obſerved, which are generally conceived to be the mouths of ſmall ſalivary ducts *. This ſecreting mucous ſurface begins here, towards the root of the tongue, to reſemble the glandular ſtructure of the œſophagus, which, by bedewing the ſurface of the morſel, fits it for an eaſy paſſage through the gullet. In this roughneſs of the root of the tongue, there ſeems to be a proviſion for the detenſion of the ſapid particles, and the prolonging of the ſenſations of taſte.

* Vater, who injected theſe ducts, found them terminating in a gland near the os hyoides; and his opinion was, that they had even a connection with the thyroid gland. Heiſter was of the ſame opinion.

The PAPILLÆ peculiar to the human tongue, are divided into four claſſes. 1. Theſe larger papillæ upon the root of the tongue are the truncatæ; and they are often ſtudded on the dorſum of the tongue in a triangular form. 2. The fungiformes are obtuſe papillæ found more forward on the tongue; they are little hemiſpherical tumid papillæ, or of a cylindrical ſhape, with an obtuſe apex. Theſe are interſperſed among the 3d. diviſion, the moſt numerous and univerſally prevalent papillæ, viz. viloſi or conicæ. 4. The more important papillæ, however, are thoſe which are endowed with peculiar ſenſibility to ſapid bodies; they are to be diſtinguiſhed by their ſuperior redneſs and briliancy upon the point and edges of the tongue.

The tongue is inveſted with the cuticle and rete mucoſum, like the ſkin in other parts. The lower ſurface of the tongue is ſimilar to the general lining membrane of the mouth being a villous and ſecreting ſurface. It is reflected off upon the bottom of the mouth. It forms here the frenulum linguæ. This ligament ſeems evidently intended to limit the motion of the point of the tongue backwards. I believe a very falſe opinion has much prevailed, that the ſhortneſs of this ligament, or its being continued too far forward toward the point of the tongue, prevents the child from ſucking. The tongue, as I conceive, would ſufficiently perform the neceſſary action on the mother's nipple, although its lower ſurface were univerſally adhering to the bottom of the mouth. But, obſerve the bad conſequences which may ariſe from cutting this frenulum,

frenulum, from the obſtinate importunity of the nurſe, or the weakneſs of a ſurgeon. The ranine vein or artery which runs near it may be cut, and the child will continue ſucking and ſwallowing its own blood; and children have actually died, and the ſtomach has been found diſtended with blood! But there is another more dreadful accident from this cutting of the frenum linguæ. A child, ſays Mr. Petit, whoſe frenum had been cut almoſt immediately after its birth, was ſuffocated, and died five hours afterwards. They believed that the operation was the cauſe of the child's death; they ſent for me to open the body. I put my finger into its mouth, and I did not find the point of the tongue, but only a maſs of fleſh, which ſtopped up the paſſage from the mouth into the throat. I cut up the cheeks to the maſeter muſcles, to ſee what had become of the tongue; I found it turned like a valve upon the fauces, and the point actually ſwallowed into the pharynx. "Some time after," continues Mr. Petit, "I was called to the child of Mr. Varin, Sellier du Roi, whoſe frenum they had cut two hours after its birth, and who, a little after, had fallen into the ſame ſituation with the child I have now mentioned, and was nearly ſuffocated. My firſt care was, to introduce my finger, the tongue was not, as yet, entirely reverſed into the throat. I brought it back into the mouth; in doing which, it made a noiſe like a piſton when drawn out of its ſyringe." Mr. Petit waited to find the effect of its ſucking, and, after hearing the action of deglutition for ſome minutes, the child fell again into the ſame ſtate of ſuffocation. Several times he reduced the

the tongue, and, at laſt, contrived a bandage to preſerve it in its place; but, by the careleſſneſs of the nurſe, the accident recurred, and the child was ſuffocated during the night.

CHAP. II.

OF THE SALIVARY GLANDS.

THE fources of the faliva are very numerous; the parotid glands or fuperior maxillary gland, and focia parotidis; the inferior maxillary or fubmaxillary glands; the fublingual glands; and, (according to the opinion of many), the glandular folicules of the root of the tongue: the palate, and even the buccinales and labiales, or glands of the cheeks and lips, are alfo to be enumerated, as fources of faliva.

The PAROTID GLAND, as its name implies, is that which lies near to the ear. It is the largeft of the falivary glands; and it is of much importance for the furgeon to obferve its extent and connections. A great part of it lies before the ear, and betwixt the ear and jaw. It extends over the mafeter mufcle, and upward to the zigoma. But there is alfo a great part of it which lies below the tip of the ear, and betwixt the angle of the jaw and the maftoid procefs. Its furface is unequal, and compofed of little maffes or lobules of gland, united by a cellular membrane. The duct of this gland was difcovered by Needham, and afterwards by Steno: it is very often called Steno's duct. When it is injected with quick-filver, the branches are feen diftributed in a moft beautiful and minute manner amongft the lobuli of the gland, and fimilar to the branching

branching of veins. Theſe branches have a direction upward, and unite into a trunk, which paſſes from the upper part of the gland acroſs the cheek over the origin of the maſeter muſcle: it then pierces the buccinator muſcle, and opens upon the inner ſurface of the cheek, oppoſite to the ſecond or third dens molaris. This duct has ſtrong white coats; but, although the mouth of the duct is very ſmall, the duct itſelf is delatable to a great ſize, ſo that tubes of a conſiderable ſize have ſlipt into it, and been buried in the body of the gland.

The SOCIA PAROTIDIS is a ſmall gland, (which, however, is by no means conſtant), ſeated on the upper ſide of the duct of the parotid gland, and juſt under the margin of the cheek-bone. It opens by a leſſer duct into the great duct of Steno. Sometimes, however, inſtead of one conſiderable gland, there are ſeveral ſmall ones, ſeated in the courſe of the great duct, and opening into it by ſeveral minute ducts.

OF THE SUBMAXILLARY AND SUBLINGUAL GLANDS. The ſubmaxillary gland is of a regular oval figure; it lies on the tendon of the digaſtric muſcle, and is defended by the angle of the lower jaw, while it is generally connected with, or involves the root of the focial artery. It is regularly lobulated; and its duct paſſes forward between the genioglosſus and mylohyoideus, and under the ſublingual gland. The openings of the ſubmaxillary ducts, or ducts of Wharton, are very eaſily diſtinguiſhed. They open very near each other on each ſide of the frenum linguæ, very near the gums of the dentes inciſivi; ſo that they appear as if tied down by the frenum. When theſe

are

are excited to difcharge their fluids, they become a little erected, their patent mouths are feen diftinctly, and the tortuous courfe of their canal in the bottom of their mouth may be obferved.

The SUBLINGUAL GLAND is of a flat and elongated form; it lies clofe under the tongue between the genio-hyo-gloffus and mylo-hyoideus mufcles. It is the fmalleft of the three great falivary glands. The two fublingual glands ftretching clofely under the tongue, they are feparated from the mouth only by the membrane of the mouth. They have no large duct, but open by fmall lateral ducts, with loofe pendulous mouths upon the lower furface of the tongue. Befides the leffer glands, which every where are found under the lining membrane of the mouth, Heifter, Verdier, and M. de Bordeu, have defcribed a glandula molaris, feated betwixt the buccinator and mafeter mufcles.

From the general furface of the lips, tongue, cheek, and palate, there is a fluid exhaled. This exhaling furface, and all thofe glands, are excited to action by the fame ftimulus with the membrane of the mouth. The faliva moiftens the furface of the mouth, affifts in manducation, and preparing the food to be fwallowed and acted upon by the ftomach, and accelerates digeftion. As the mouth is an exhaling furface, fo is it an imbibing and abforbing furface.

CHAP. III.

VELUM PALATINUM; UVULA; ARCHES OF THE PALATE; AND AMYGDALÆ.

THE VELUM PENDULUM PALATI is the vafcular and flefhy membrane, which, hanging from the bones of the palate, divides the mouth from the fauces and throat. It is not a fimple membrane, but has betwixt its laminæ many glands, which open upon its furface by little patent folicules, and is thickened and ftrengthened by mufcular fibres: fo that it is more of a flefhy partition, ftretching backward and eking out the palate, than a hanging membrane.

The edge of the velum palati is not fquare, but turned into elegant arches; and, from the middle of the arches of the palate, hangs down the UVULA, fo named from its refemblance to a grape. It is a large, foft, and glandular papilla, peculiarly irritable and moveable, having in it mufcular fibres, and hanging from the moveable foft palate. It feems to hang as a guard over the fauces, and, by its fenfibility, in a great degree governs the operation of thefe parts.

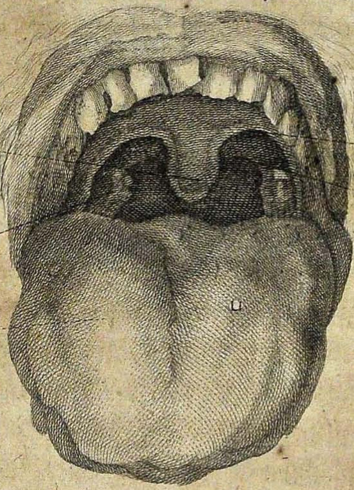
The ARCHES OF THE PALATE OR FAUCES defcend on each fide from the velum palati. They are mufcular fibres, covered with the foft vafcular and folicular membrane of the fauces *. There are two on

* See vol. I. Conftrictor Ifthmi faufcium and Palato-pharyngeus.

each

each ſide. Theſe arches ſtand at ſome diſtance from each other, ſo that the iſthmus of the fauces reſembles the double-arched gateway of a citadel, or the arched roof of a cathedral, with the uvula hanging as from the central union of four ſemicircular arches.

Fig. 20.



Behind the ſoft palate is the opening of the noſe backward into the throat. Now, the uſe of the velum is that in ſwallowing it may be drawn up like a valve upon the poſterior opening of the noſe; and there being, at the ſame time, an action of the arches of the palate, the whole is brought into a funnel-like ſhape, directing the morſel into the pharynx and gullet. In this action, the direction of the food aſſiſts, but, in vomiting, the valvular-like action of the velum is not ſo accurate; and often the noſe is aſſailed with the contents of the ſtomach.

AMYGDALÆ. Under the velum palati, and betwixt the arches of the palate on each ſide, lies a large oval gland of the ſize and ſhape of an almond. Theſe are the tonſils or amygdalæ. The amygdala is a mucous gland:

gland: it is loosely covered with the investing membrane of these parts: its surface is seen, even in a living person, to be full of large cells like lacunæ; these communicate; and the lesser mouths of the ducts open into them. The gland is of a soft relaxed nature, adapting itself to the extensive motion of those parts. From this naturally loose texture, and from its being a vascular and secreting body, exposed to the immediate vicissitudes of weather, it is often inflamed, and greatly impedes the action of the surrounding muscular fibres in the action of deglutition. The use of the amygdala is evidently to lubricate the passage of the throat, and facilitate the swallowing of the morsel; and, for this reason, are the mouths of its ducts cellular and irregular, that they may retain the mucus until ejected by the action of deglutition. In this operation, the amygdalæ are assisted by numerous lesser glands, which extend all over the arches of the palate and pharynx. But these are parts which come again to be recapitulated, as introductory to the account of the structure of the œsophagus and stomach, in the succeeding volume.

CHAP. IV.

OF THE SENSE OF TASTING.

On the ſurface of the tongue are to be obſerved erect papillæ. In theſe the extremities of the guſtatory nerve are expended, and they are the ſeat of the ſenſe of taſting. Theſe papillæ are in the true ſkin of the tongue, and are extremely vaſcular. They are covered by the rete mucoſum, and a very fine cuticle, and indeed they have much reſemblance to the papillæ of the ſkin; while, betwixt theſe papillæ, there is a fleece or down bearing a perfect analogy to the vili of the ſkin. The papillæ, which are the organs of taſte, are to be ſeen on the point and edge of the tongue, and conſiſt of a pretty large vaſcular ſoft point which projects from an opaque and white ſheath. If we take a pencil and a little vinegar, and touch or even rub it ſtrongly on the ſurface of the tongue, where thoſe papillæ are not, the ſenſation only of a cold liquid is felt; but when you touch one of theſe papillæ with the point of the bruſh, and at the ſame time apply a magnifying glaſs, it is ſeen to ſtand erect and riſe conſpicuouſly from its ſheath, and the acid taſte is felt to paſs as it were backward to the root of the tongue. The exquiſitely ſenſible papillæ are placed only on the point and edge of the tongue; for the middle of the tongue is rough, and ſcabrous, not

to give the ſenſation of taſte, but to force the ſapid juices from the morſel, or break down the ſolids againſt the roof of the mouth, and aſſiſt in their ſolution. The more delicate and vaſcular papillæ would be expoſed to injury if ſituated on the middle of the tongue. Before we taſte, the ſubſtance diſſolved in the ſaliva flows over the edges and point of the tongue, and then only comes in contact with the organ of taſte.

It would appear, that every thing which affects the taſte muſt be ſoluble in the ſaliva; for without being diſſolved in this fluid, it cannot enter readily into the pores and inequalities of the tongue's ſurface.

A curious circumſtance, in the ſenſe of taſte, is its ſubſerviency to the act of ſwallowing. When a morſel is in the mouth and the taſte is perfect, our enjoyment is not full: there follows ſuch a ſtate of excitement in the uvula and fauces, that we are irreſiſtibly led to allow the morſel to fall backward, when the tongue and muſcles of the fauces ſeize upon it with a voracious and convulſive graſp and convey it into the ſtomach.—The meaſure of enjoyment is then full. This laſt ſhort-lived gout is the acmè. Were not this appetite of the throat and uvula connected with the action which impells the food into the ſtamach, the complete enjoyment of the ſenſe of taſte alone would preclude the brutal reſource of the Roman feaſts: but as it is, the connection of the ſtomach and tongue is ſuch, that the fullneſs of the ſtomach precludes the further enjoyment of the ſenſe of taſte. The ſenſes of ſmelling and taſte have their natural appetites or reliſh; but they have alſo their acquired appetites, or delight

delight in things which to unſophiſticated nature are diſagreeable: ſo that we acquire a liking to ſnuff, tobacco, ſpirits, and opium. "Nature, indeed, ſeems ſtudiouſly to have ſet bounds to the pleaſures and pains we have by theſe two ſenſes, and to have confined them within very narrow limits, that we might not place any part of our happineſs in them; there being hardly any ſmell or taſte ſo diſagreeable that uſe will not make it tolerable, and at laſt, perhaps, agreeable; nor any ſo agreeable as not to loſe its reliſh by conſtant uſe. Neither is there any pleaſure or pain of theſe ſenſes which is not introduced or followed by ſome degree of its contrary which nearly balances it. So that we may here apply the beautiful allegory of the divine Socrates: That although pleaſure and pain are contrary in their nature, and their faces look different ways, yet Jupiter hath tied them ſo together, that he who lays hold of the one draws the other along with it."

BOOK V.

OF THE SKIN AND OF THE SENSE OF TOUCH.

OF TOUCH AND OF THE SKIN.

By the ſenſe of touch we perceive ſeveral qualities, and of very different kinds: hardneſs, ſoftneſs, figure, ſolidity, motion, extenſion, and heat and cold. Now, although heat be a quality, and cold the privation of that quality, yet in relation to the body, heat and cold are diſtinct ſenſations. But in a more preciſe acceptation of the term, the ſenſe of touch is ſaid to be the change ariſing in the mind from external bodies applied to the ſkin, and more eſpecially to the ends of the fingers.

To underſtand the organization adapted to this ſenſe, we muſt premiſe, in a ſhort view, the ſtructure of the ſkin.

OF THE SKIN.

The ſkin is diviſible, by the art of the anatomiſt, into four laminæ or membranes, diſtinct in texture and appearance as in their function or uſe, viz. the cuticle, or

or epidermis; the corpus mucofum, or reticular tiffue; the cutis vera dermis, or true fkin: but from this laft there is feparated a vafcular membrane, below which is the organized furface of the true fkin.

The CUTICLE OR EPIDERMIS, OR SCARF SKIN, is the moft fuperficial lamina of the fkin: it is a tranfparent and infenfible pelicle which ferves, in fome degree, to refift the impreffion of external bodies on the furface of the body, and to blunt the otherways too acute fenfation of the cutis vera. In man it is very thin, unlefs in thofe parts which are expofed to the contact of hard bodies, as the palms of the hands and foles of the feet. The thicknefs of the cutticle there, however, is not altogether the effect of labour and walking, but there is even in the fœtus a provifion for the defence of the fkin in thefe places. This is particular, that by labour or continued preffure on the cutticle it does not abrade and become thin and tender, but thicker, harder, and the part more infenfible, fo as even to acquire a horny hardnefs and tranfparency. Of this we have an example in the hands of fmiths, and in a remarkable manner in the feet of thofe who have been accuftomed to walk bare-foot on the burning fands. It is thus a protection in a ftate of nature; but when the foot comes to be unnaturally pinched in fhoes, the hard leather works perpetually on a point of the toes, excites the formation of cutticle in the fkin below, which thrown outward by fucceeding layers of cutticle, at laft forms a corn or clavus, and which, like a fmall nail, has a broad head with a conical point fhooting into the tender fkin.

The cutticle is perforated by the extremities of the perfpiring and abforbing veffels, and by the ducts of

the glands of the ſkin. Indeed, when the ſmall pores of the ſkin or foramina are examined narrowly, the cutticle is ſeen to form ſheaths which enter into them, and which, when torn out, are like little tubes having a perforated point.

When, by maceration, the cutticle is ſeparated from the ſkin, as we draw it off we ſee little proceſſes of the cutticle, which enter into the pores of the ſkin.

Mr. Cruickſhanks enumerates three claſſes of proceſſes: there appear evidently two. The firſt lines the pores through which the hairs paſs: theſe are the longeſt, and generally have the longeſt diameter. The ſecond claſs is eaſily diſtinguiſhed on the inſide of the cutticle, which covers the palms of the hands or ſoles of the feet, or indeed on any part of the cutticle; and they appear in regular order on thoſe parts of the cutticle which correſpond with the parallel or ſpiral ridges of the cutis. The ſurface of the cutticle is uniform next the ſkin; but, on the outer ſurface, it is rough and ſquamous. Theſe ſquamæ are the portions of the cutticle, which, breaking up, are rubbed off; and thus there is a perpetual change, by the formation of new cutticle under the old, and the abraſion or diſquamation of the old ſurface.

In youth, the cutticle is thin and tranſparent; in old age, it becomes thick, rough, and furrowed:

——— deformem pro cute pellem
Pendenteiſque genas et taleis adſpice rugas
Qualeis umbriferos ubi pandit tabraca ſaltus
In vetula ſcalpit jam mater ſimia bucca.

The

The NAILS are naturally connected with the cutticle, for they remain attached to it, and separate from the true skin by maceration and beginning putrefaction. The nails are to give firmness and resistance to the points of the fingers. Although they take a very universal adhesion, it is chiefly from the root that they grow and shoot out to the point of the fingers, to which they adhere firmly. Over the root of the nail the cutticle projects, and under it the rete mucosum is extended; and under this, and defended by it, are the papillæ of the skin also.

Like the cutticle, the nails are without vessels or sensation: they are undergoing a perpetual growth, and are worn down by labour. When cherished, they grow to an amazing length, and curve a little over the points of the fingers; and serve, in some nations, as a most unequivocal sign of perfect idleness and consequent gentility, since the fingers become absolutely useless. By disease, I have seen very large crooked horns projecting from the stool of the nail of the toes. They were thus monstrously encreased by superimposed laminæ shoved off by the more recent ones.

OF THE HAIRS.

The hairs grow from a bulbous root, seated in the cellular membrane. This bulb is vascular, and has connection, by vessels, with the cellular texture. It consists of a double membrane; the outer is a kind of capsule which surrounds the other, and stops at the pore in the skin, and does not form part of the hair.

Betwixt theſe capſules, there is a cellular tiſſue, and the ſpace is commonly found filled with a bloody fluid. In the bottom of the inner ſac, there is a ſmall body, called monticule by Duverney, from which the hair is ſeen to ariſe; and if this is left when the bulb of the hair is pulled out, the hair will be regenerated.

The root of the hairs, ſays Mr. Winſlow, is covered by a ſtrong white membrane, which is connected with the ſkin and cellular membrane. Within the root, there is a kind of glue, ſome fine filaments of which advance to form the ſtem which paſſes through the ſmall extremity of the bulb to the ſkin. As the ſtem paſſes through the root, the outer membrane is elongated in form of a tube, which cloſely inveſts the ſtem and is entirely united with it. And many authors agree, that the hair does not perforate the cutticle, but takes from it merely a vagina which accompanies it.

RETE MUCOSUM.

The rete or corpus mucoſum, lies betwixt the cutticle and the ſurface of the true ſkin. It is a mucous layer, pervaded by the little fibrillæ paſſing betwixt the ſkin and cutticle. I conſider it as a ſoft bed to envelope and preſerve the papillæ of the ſkin, and as intended to become cutticle in due ſucceſſion. It was conſidered, by Albinus, as of a nature adapted to imbibe the fluids through the cutticle, and as a production of the epidermis. M. Meckel believed it to be only a mucous fluid, inſpiſſated into the form of a membrane; and that it was diſſolved by putrefaction, while the ſkin and cutticle remained firm. It is the ſeat of colour in the

ſkin,

ſkin, and is of a white tranſparency in the albino, and in the inhabitants of temperate climates. It is black in the negro; copper coloured in the mulatto; yellow in the Egyptian. It is ſuppoſed to preſerve the negro from the heat of the climate; but I conceive that the power of reſiſting the baneful effects of warm climates, muſt be looked for in other conſtitutional peculiarities: for certainly a ſurface which abſorbs the light muſt produce heat more rapidly than a white one, which repels it. The ladies know that the effect of a black veil, in intenſe ſun-ſhine, is to ſcorch the cheeks. The rete mucoſum changes its ſhades of colour in Europeans, from the effect of light, and sometimes makes changes in the conſtitution, as in the colour of the areolæ which ſurround the nipple.

While the rete mucoſum has its peculiar uſe of defending the delicate ſurface of the papillæ of the ſkin, I conceive it to be undergoing a perpetual change; to be thrown off in ſucceſſion from the vaſcular ſurface of the ſkin, and in its turn to form the cutticle by its outer layers. The inner ſurface of the rete mucoſum is ſofter and more pulpy, the outward ſurface more allied to the cutticle, which gives occaſion to Mr. Cruickſhanks to ſay it is double.

Under the rete mucoſum and on the ſurface of the ſkin, there is a ſoft vaſcular membrane, which is ſtill above the porous and glandular true ſkin. It was firſt demonſtrated by injections in ſubjects who had died of ſmall-pox, and is alſo ſo much ſtrengthened by other inflammatory actions of the veſſels of the ſkin, as to be capable of demonſtration. It was at firſt ſuppoſed that this vaſcular

vaſcular membrane was the rete mucoſum ſucceſsfully injected; but afterwards it was found, that this vaſcular membrane exiſted independently of the rete mucoſum *. Mr. Cruickſhanks conceives that it is cutticle in its ſtate of formation, and that the rete mucoſum is in fact a cutticle advancing to the ſtate of perfect maturation. But I ſhould rather believe that this is a vaſcular ſurface, not changeable, nor loſing its vaſcularity to be thrown off in form of rete mucoſum; but, in itſelf, the organized ſurface, which is to form the rete mucoſum, and which excretion does in ſucceſſion become cuticle. This vaſcular ſurface of the ſkin, for ſuch I muſt ſuppoſe it, although it be capable of being ſeparated by long maceration and putrefaction, into ſomething like a diſtinct membrane, is the ſeat of the ſmall-pox puſtule, and probably of many other cutaneous diſeaſes.

There are three laminæ above the true ſkin, diſtinguiſhed by their character; the cutticle, the rete mucoſum, and the vaſcular membrane: but as ſome have divided the rete mucoſum into the lamina, Mr. Cruickſhanks has ſeparated two vaſcular layers from the ſurface of the ſkin. They, who are fond of ſuch minute ſubdiviſions, may thus enumerate five laminæ or membranes, before coming to the porous ſurface of the true ſkin.

* Mr. Baynham, who diſcovered this vaſcular ſurface, conceived that he had injected the rete mucoſum. We are to find the further elucidation of this piece of anatomy from Mr. Cruickſhanks.

OF

OF THE TRUE SKIN.

The true ſkin is the denſe, elaſtic, and vaſcular membrane which is under theſe outer laminæ, already treated of. While it has firmneſs, ſtrength, and elaſticity to defend the body; it is alſo an organized ſurface, as important in its function and the healthy action of the ſyſtem depending upon it nearly as cloſely as on the action of the lungs and ſurface of the inteſtines.

The ſkin is denſe on the outer ſurface, while the internal layers are looſe, and gradually degenerate into the cellular ſubſtance. On the lips, eye-lids, &c. the ſkin becomes thin and tranſparent.

We have to attend to the pores and vili of the ſkin: on narrowly obſerving the ſurface of the ſkin, we find it irregularly porous. Theſe are the ducts of ſebaceous glands, which are lodged in the ſkin. They tranſmit the hairs alſo, and are the perſpiring and, probably, the abſorbing pores; or, at leaſt, within theſe larger pores it is probable the abſorbing and tranſpiring veſſels terminate. Theſe pores are moſt remarkable about the noſe, mouth, palms of the hands, and ſoles of the feet. Into theſe pores of the true ſkin, as we have mentioned, little ſheaths of the cutticle enter, and through theſe ſheaths the perſpiring matter muſt conſequently eſcape. But, in death, the action of the perſpiring veſſels ceaſing, the pores of the cutticle are no longer pervious to the fluids, and there is no perſpiration or exudation through them.

The vili of the ſkin project above its ſurface, like the pile of velvet. They vary much in ſize, and are, in ſome

ſome places, very much prolonged. They conduct the ſenſible extremities of the cutaneous nerves to form the organ of the ſenſe of touching; and, like the papillæ of the tongue, they ſuffer an erection and excitement preparatory to the reception of the impreſſion.

EXPLANATION

OF THE

PLATES.

PLATE V.

FIG. I.

THE eye with the cornea cut away, and the ſclerotic coat diſſected back *.

a. THE OPTIC NERVE.

b. The SCLEROTIC COAT diſſected back, ſo as to ſhow the veſſels and nerves of the choroid coat.

cc. THE CILIARY NERVES ſeen piercing the ſclerotic coat, and paſſing forward to be diſtributed to the iris.

d. A ſmall nerve paſſing from the ſame ſource to the ſame deſtination, but appearing to give off no branches.

* See Zinn, Tab. iv.

ee. Two

e e. Two of the VENÆ VORTICOSÆ.

f. A point of the ſclerotic coat through which the trunk of one of the veins had paſſed.

g. A leſſer venous trunk.

h. The orbiculus ciliaris of Zinn; the ciliary ligaments of others.

i. The IRIS.

k. The ſtreight fibres of the iris.

l. A circle of fibres or veſſels which divide the iris into the larger circle k, and the leſſer circle m.

m. This points to the leſſer circle of the iris.

n. The fibres of the leſſer circle.

o. The pupil.

FIG. 2.

A diſſection of the coats of the eye, as they appeared when hung in ſpirits.

A. The OPTIC NERVE.

B. The SCLEROTIC COAT folded back.

C. The CHOROID COAT hanging by its attachment to the ſclerotic coat.

D. The veſſels of the RETINA ſeen as they appeared ſuſpended in the fluid; the medullary part of this coat being waſhed away.

Explantion of Plate VI.

Fig. 1.

The lens covered with its capſule, and minutely injected in the fœtus calf.

A. The arteria centralis retinæ.

B. The fringe remaining with the margin of the lens from the attachment of the veſſels of the ciliary body.

Fig. 2.

This figure ſhews the attachment of the capſule of the lens to the membrana pupillaris, in the fœtus calf.

A. The capſule of the lens very minutely injected; the lens has been allowed to eſcape, and the membrane hangs by its attachment to the membrana pupillaris.

B. That part of the capſule which covers the fore part of the lens; in which, not a veſſel is to be ſeen.

C. The membrana pupillaris, very minutely injected.

D. The iris, to the circle of which, the membrana pupillaris is ſeen to be attached, and, conſequently, to cloſe the pupil.

E. The ciliary processes.

Fig. 3

FIG. 3.

The CILIARY PROCESSES, the IRIS, and MEMBRANA PUPILLARIS, as they appear in the human fœtus of the ſeventh month.

FIG. 4.

The appearance of a veſſel which took its courſe acroſs the pupil in the full grown fœtus, indicating, that the membrana pupillaris was ſtill preſent, although it had become pellucid.

FIG. 5.

A ſection of the optic nerve, to ſhow its great degree of vaſcularity.

A. The body of the nerve quite red with injection.

B. The coat of the nerve.

EXPLANATION OF PLATE VII.

FIG. 1.

The repreſentation of an eye with a cataract, diſſected.

A. The CORNEA cut from the ſclerotic coat, and hanging by a ſhred.

B. The

B. The SCLEROTIC COAT.

C. The IRIS.

D. The OPAQUE LENS OR CATARACT, it is ſeen to have formed an adheſion with the iris.

FIG. 2.

This figure repreſents the effect of couching a ſoft cataract. The needle, inſtead of depreſſing the cataract, cut it into three pieces.

A A. The cut edge of the SCLEROTIC COAT.

B. The CHOROID COAT, and CILIARY PROCESSES.

C. The cataract adhering to the ciliary proceſſes in three diſtinct pieces.

FIG. 3.

This figure repreſents the place into which the couching needle muſt be introduced.

A. The PUPIL ſeen through the tranſparent cornea.

B. The IRIS.

C. The NEEDLE, with the handle elevated, ſo as to depreſs the point.

D. The lens and point of the needle in outline; this repreſents the poſition of the lens when depreſſed: to complete the operation, it muſt be carried a little back before withdrawing the needle.

FIG. 4.

A ſcheme, ſhewing the bad effect of introducing the needle near the margin of the cornea.

A. The VITRIOUS HUMOR.

B. The LENS.

C C. The CILIARY BODY; on the lower part, torn by the needle.

D D. The IRIS.

E. The anterior chamber of the aqueous humor.

FIG. 5.

Shows the ſituation of the cataract when depreſſed.

A. The ANTERIOR CHAMBER of the aqueous humor.

B. The POSTERIOR CHAMBER of the aqueous humor.

C. The iris.

D. The VITRIOUS HUMOR occupying the ſeat of the lens.

E. The depreſſed lens or cataract.

EXPLANATION OF PLATE VIII.

Showing ſome varieties in the ſtructure of the ear in the lower animals.

FIG. 1.

Fig. 1.

The ear of the lobſter.

A. The membrane which covers the projecting mouth of the ſhell containing the organ of hearing.

B. A tranſparent pulp or veſicle, upon the bottom of which, the web of the nerve is expanded.

C. The inſide of the ſhell containing the organ, which is, of courſe, repreſented broken open.

Fig. 2.

This repreſents a little bone which is ſuſpended in contact with the pulp of the nerve, and which is ſeen but imperfectly in the firſt figure.

A. The bone.

B. An elaſtic membranous, or rather, cartilaginous ſubſtance, by which the bone is ſuſpended.

Fig. 3.

The head of a haddock with the bones broken up, to ſhew the brain and ſemicircular canals.

A. The BRAIN.

B. The SEMICIRCULAR CANALS.

Fig. 4.

The organ of hearing taken out and diſplayed.

A. The SACCULUS VESTIBULI.

B. The boney concretion which lies within, and which, by its vibration, encreaſes the impulſe.

C. The AUDITORY NERVE paſſing to be diſtributed on the ſacculus veſtibuli, and the extremities of the ſemicircular canals.

D D D. The three SEMICIRCULAR CANALS.

E. One of the extremities of the ſemicircular canals in which the branch of the nerve is ſeen to be expanded.

F. A leſſer diviſion of the auditory nerve.

FIG. 5.

The head of a frog with the ſkin taken off; and we now ſee the cavity of the tympanum in this animal, over which the common integuments of the head ſpread tenſe, ſo as to anſwer the purpoſe of the membrana tympani.

A. The point of a little elaſtic bone which is attached behind the tenſe integuments, and receives their vibration. Its further connections are ſeen in the next figure.

FIG. 6.

A magnified view of the internal ſtructure of the frog's ear.

A. The firſt bone, which is attached to the ſkin.

B. The ſecond bone, which has its inner extremity enlarged ſo as to fill up the foramen ovale, which leads into the inner cavity of the ear.

C. The

C. The great inner cavity of the ear of this animal, anſwering to the veſtibule of the more perfect ſtructure.

D. A chalky concretion which lies within this cavity.

FIG. 7.

The head of a ſerpent.

A. A bone connected with the lower jaw.

B. A bone which paſſes from the integuments (behind the large bone A) to the opening into the cavity of the ear, and which, of courſe, receives and conveys the vibration of ſound into the cavity which contains the expanded nerve.

FIG. 8.

The HEAD of the LAND TORTOISE.

A. A large ſcale which ſerves the uſe of the membrana tympani.

B. A ſingle bone which is ſeen to paſs through the cavity of the tympanum; it is attached by an elaſtic bruſh of fibres to the ſcale A, and is enlarged to a head upon its inner extremity. This, filling up the foramen of the inner cavity, conveys the vibration.

Explanation of Plate IX.

In this plate, the anatomy of the bones of the human ear is explained.

Fig. 1.

We have here the bones which form the chain betwixt the membrane of the tympanum and the membrane of the foramen ovale.

A. The MALLEUS.

B. The INCUS.

C. The STAPES.

D. The OS ORBICULARE which forms the articulation betwixt the incus and ſtapes.

Fig. 2.

In this figure, we have a view of the inſide of the temporal bone, the petrous portion being broken away: we ſee the cavity of the tympanum, the membrane of the tympanum, and the chain of bones.

A. The groove for the lodgement of the lateral ſinus.

B. The hole in the ſphenoid bone for the paſſage of the artery of the dura mater.

C. The petrous portion of the temporal bone.

D. The irregular CAVITY of the TYMPANUM laid open by the breaking off of the petrous part of the temporal bone.

E. The

E. The MEMBRANE of the TYMPANUM closing the bottom of the meatus auditorius externus.

F. The MALLEUS, the long handle of which is seen to be attached to the membrane of the tympanum E.

G. The INCUS, united to the great head of the malleus F.

H. The STAPES, which is seen to be articulated with the long extremity of the incus through the intervention of the os orbiculare.

FIG. 3.

Shows the division of the temporal bone into the squamous and petrous portions.

FIG. 4.

A. The SQUAMOUS PART of the temporal bone.

B. The CIRCULAR RING, which forms the meatus auditorius externus in the child.

C. The ZIGOMATIC PROCESS.

D. Cells, which afterwards enlarge into those of the mastoid process.

FIG. 5.

The petrous portion of the bone, with a view of the tympanum.

A. The CAVITY of the TYMPANUM.

B. MASTOID

B. MASTOID CELLS.

D. The FORAMEN OVALE, into which the ſtapes (ſee fig. 1. C. and fig. 2. H.) is lodged.

E. The more irregular opening of the FORAMEN ROTUNDUM.

FIG. 6.

Repreſents the labyrinth of the human ear, with the ſolid bone which ſurrounds it cut away.

A. The FORAMEN OVALE.

B. The three SEMICIRCULAR CANALS.

D. The COCHLEA.

E. The tube, which conducts the portio dura of the ſeventh pair through the temporal bone.

FIG. 7.

Explains the manner in which the lamina ſpiralis divides the cochlea into two ſcalæ, and the opening of the one ſcala into the common cavity of the veſtibule, and the termination of the other in the foramen rotundum.

A. The bone broken, ſo as to ſhow the cavity of the tympanum.

B. The FORAMEN OVALE.

C. Cellular ſtructure of the bone.

D. The FORAMEN ROTUNDUM.

E. One of the SCALÆ of the cochlea, which is ſeen to terminate in the foramen rotundum.

F. The

F. The other ſcala, which is ſeen to communicate with the veſtibule.

EXPLANATION OF PLATE X.

Theſe two figures are taken from the beautiful plates of Profeſſor Scarpa, and illuſtrate the ſoft parts contained within the oſſeous labyrinth, and the diſtribution of the nerves.

FIG. 1.

There is ſeen the membranous ſemicircular canals, their common belly, and the diſtribution of the acauſtic or auditory nerve.

a. The AMPULLA of the ſuperior membranous ſemicircular canal.

b. The SUPERIOR MEMBRANOUS SEMICIRCULAR CANAL.

c. The AMPULLA of the external membranous canal.

d. The other extremity of the external canal.

e. The AMPULLA of the poſterior membranous ſemicircular canal.

f. The POSTERIOR SEMICIRCULAR CANAL.

g. The common canal of the ſuperior and poſterior canal.

h h. The ſac common to the membranous ſemicircular canals, viz. the ALVEUS COMMUNIS.

i. The

i. The body or trunk of the ACUSTIC NERVE.

k. The larger branch of the nerve.

l. A filament of the nerve to the ſacculus veſtibuli.

m. The leſſer branch of the acuſtic nerve.

n. A filament of the cochlea.

o o. Filaments of the larger branch of the acuſtic nerve to the ampullæ of the ſuperior and exterior ſemicircular canals.

p. The expanſion of the nerve on the common alveus.

q q. NERVUS COMMUNICANS FACIEI or PORTIO DURA.

r. The beginning of the ſpiral lamina of the cochlea.

s. The oſſeous canal of the nerve, which forms part of the foramen auditorius internus.

t. The COCHLEA.

FIG. 2.

The diſtribution of the nerve in the cochlea ſeen by a ſection of the internal auditory canal and cochlea.

a. The SUPERIOR OSSEOUS SEMICIRCULAR CANAL.

b. The poſterior oſſeous ſemicircular canal.

c. The external oſſeous ſemicircular canal.

d. The bottom of the great FORAMEN AUDITORIUS INTERNUS.

e. The trunk of the great acuſtic nerve.

f. The ANTERIOR FASCICULUS of the acuſtic nerve.

g. A plexiform twiſting in the anterior faſciculus of the nerve.

h. A

h. A gangliform ſwelling of the nerve.

i. The greater branch of the anterior faſciculus.

k. The leſſer branch.

l. A filament of the anterior faſciculus to the hemi-ſperical veſicle of the veſtibule.

m. A branch to the beginning of the lamina ſpiralis.

n. The POSTERIOR FASCICULUS of the acuſtic nerve.

o. The filaments about to enter the tractus ſpiralis foraminuloſus.

p. Theſe nerves ſeen upon the modiolus.

q q. The filaments of the nerve paſſing forward betwixt the two planes of the lamina ſpiralis.

r r. Their termination on the ſoft part of the lamina ſpiralis.

s. The nerves expanded on the ſecond gyrus of the modiolus.

t t u u. Their further diſtribution on the lamina ſpiralis.

v v. The INFUNDIBULUM.

x y. The laſt turn and termination of the lamina ſpiralis in the infundibulum.

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Fig. 1.

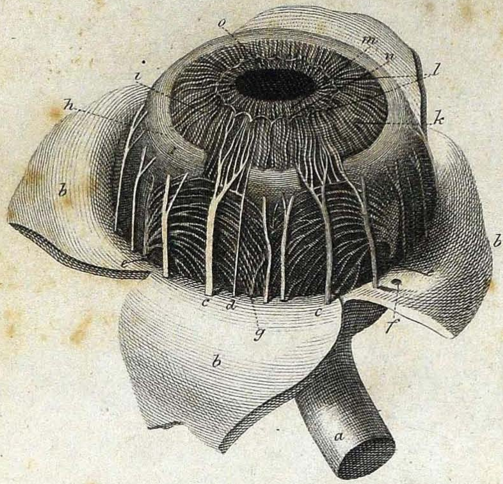

Fig. 2.

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Pla

Fig. 1.

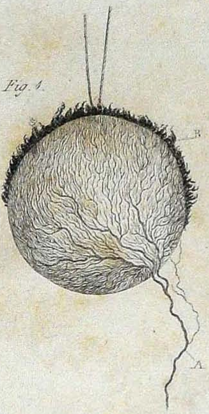
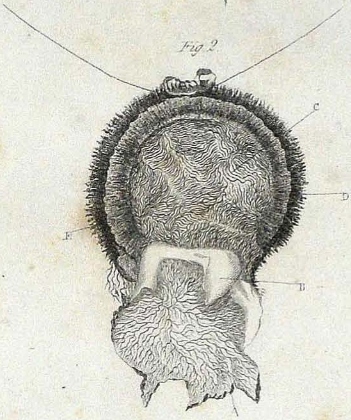


Fig. 2.



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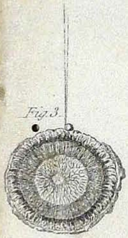

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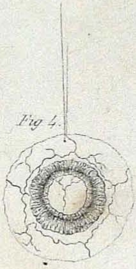

Fig. 5.

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